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# *Chemical Engineering*

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## RADIOISOTOPES

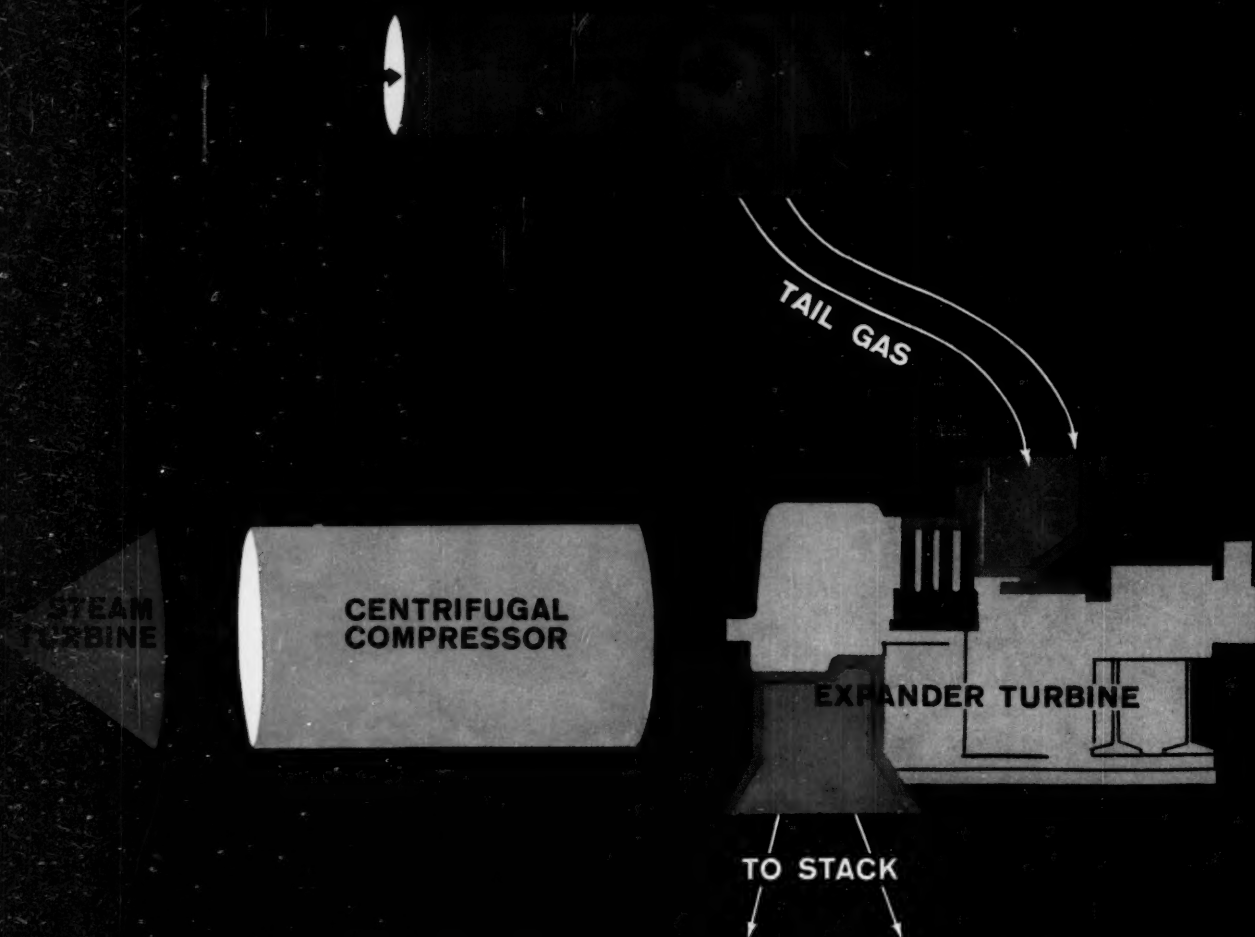
They solve production as well as research problems **page 151**

## DISTILLATION

Best control requires attention to dynamics **page 145**

## SOUND SUPPRESSION

Personnel protection pays double dividends **page 127**



# TAIL GAS WAGS PROCESS, SAVES $\frac{2}{3}$ 's POWER COSTS

In less serious moments we call it "tail-wagging." Actually, it's the art of taking substantial amounts of power from process exhaust or "tail" gases. By making the tail wag the dog . . . putting this power back into the process . . . major increases in efficiency can be obtained.

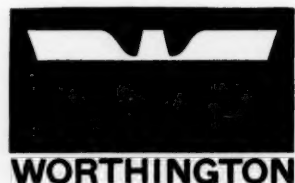
The key machine is the turbine gas expander that returns power to the process by serving as a prime mover. In one process, for example, a centrifugal compressor delivers air to the process. After reaction, in which the oxygen is removed, the residue or "tail" gas leaves the process at extremely high temperatures and under

pressure. Passed through a turbine expander, this gas does useful work.

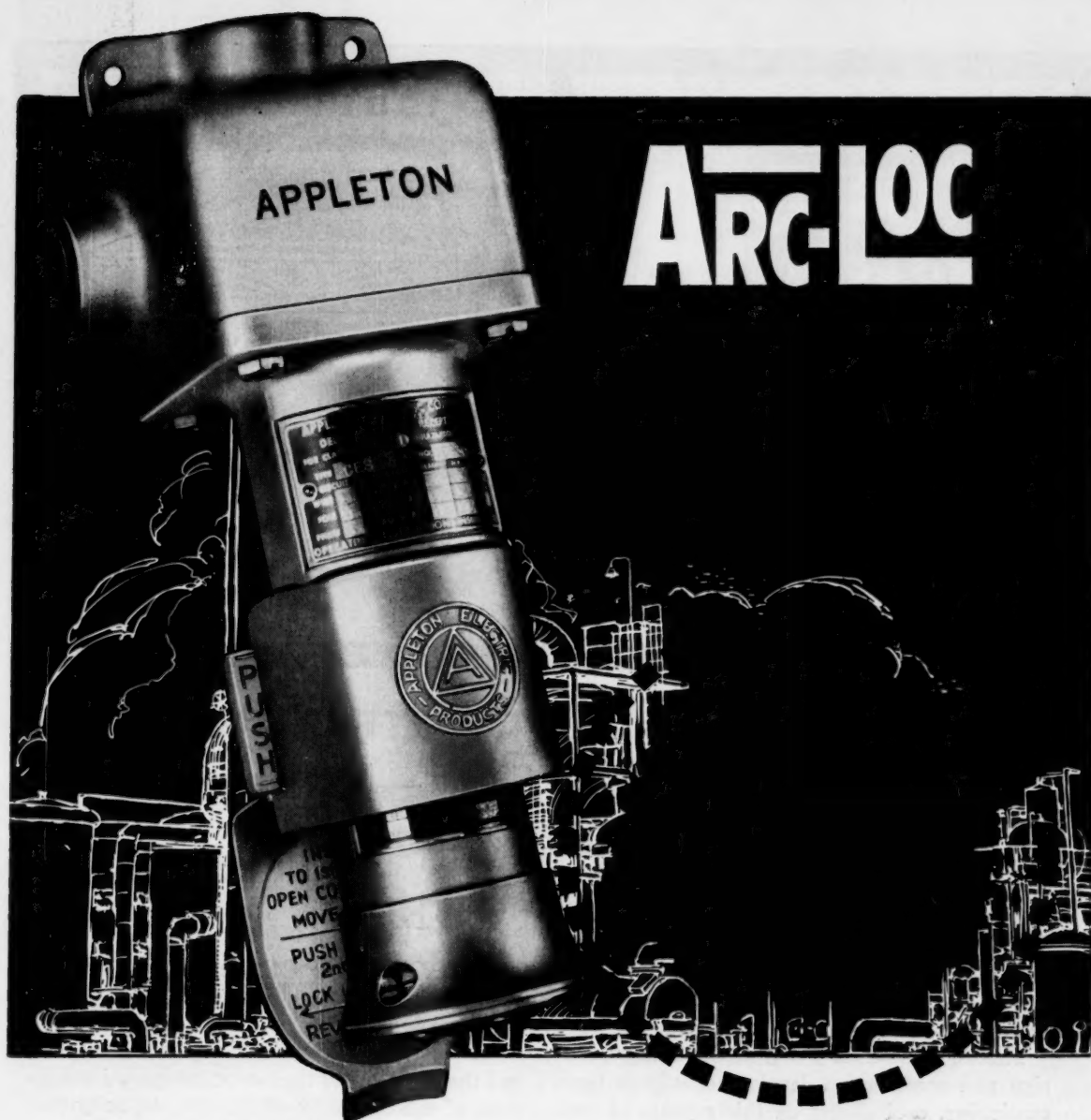
This work can be applied to driving generators, blowers or geared to reciprocating equipment. If used driving a centrifugal compressor, it can supply as high as 85% of the driving power. An auxiliary motor or steam turbine can provide the make-up and start-up power.

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plete study of this new opportunity for process plant economy. For information about "tail-wagging" (turbine gas expanders and their application) please write Worthington Corporation, Expander Section (48-10), Wellsville, New York.







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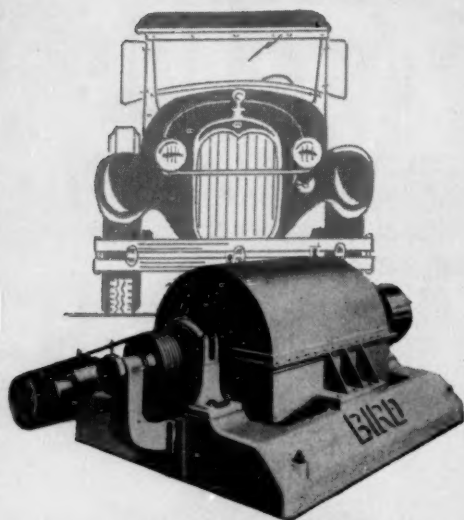
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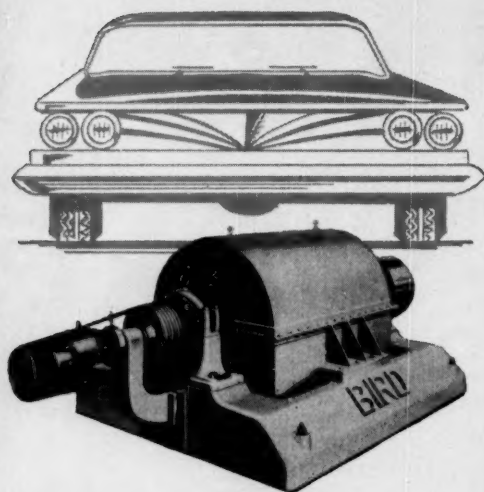
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# Chemical Engineering

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## OTHER REGULAR FEATURES

- 204 CONVENTION CALENDAR
- 214 TECHNICAL BOOKSHELF
- 222 LETTERS: PRO & CON
- 227 READER SERVICE POSTCARD
- 229 REPRINTS NOW AVAILABLE
- 226 MANUFACTURERS' LITERATURE
- 243 CLASSIFIED ADVERTISERS
- 250 INDEX OF ADVERTISERS
- 251 ADVERTISING REPRESENTATIVES

VOLUME 68, NUMBER 4

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February 20, 1961

## CHEMICAL TECHNOLOGY FOR PROFIT-MINDED ENGINEERS

### WHAT'S HAPPENING

- 73 CHEMENTATOR *R. A. Labine*
- 82 INDUSTRY AND ECONOMIC NEWS *A. V. Gemmill*
- 82 *CE Samples CPI Crystal Ball*
- 84 *Who'll Win the Top ChE Award in 1961?*
- 88 *Swing to Cold NH, Saves Storage \$\$*
- 94 *How's Business in Cryogenics?*
- 102 *CPI News Briefs*
- 104 NEW CHEMICALS *E. Guccione*
- 108 NEW EQUIPMENT *F. C. Price*
- 108 *Fast Mixer Slashes Batch Blending Cycle*
- 110 *Potentiometer Does More Things Better*
- 213 *Equipment Cost Index*
- 118 PROCESS FLOWSHEET *N. P. Chokey*
- 118 *Heavy-Water Plant Melds New Features*

### ENGINEERING PRACTICE

- 127 FEATURE ARTICLES
- 127 *Sound Suppression in the Chemical Process Industries*  
*R. L. Jacks*
- 135 *The Pro and Con of . . . Multiple-Contract Construction*  
*G. E. McGorney, W. J. McKay*
- 139 *Controlling Distillation Columns* *L. Bertrand, J. B. Jones*
- 151 *Radioisotopes Help Solve CPI Engineering Problems*  
*R. T. Overman, F. A. Rohman*
- 145 CE REFRESHER *S. Danatos*
- 145 *Analyze Material and Heat Balances for Continuous Distillation*  
*J. Coates, B. S. Pressburg*
- 158 YOU & YOUR JOB *W. C. Schall*
- 158 *What It Takes to Get That New Job* *P. J. Brennan*
- FREE—For your files, an extra copy of this article.  
Check Reader Service Postcard, p. 228
- 164 PLANT NOTEBOOK *J. R. Marshall*
- 164 *Use These One-Step Equations to Find Reboiler and Condenser Duty* *J. L. Beckner*
- 166 *Reactor Vessels Cleaned With Nitric "Vapor"*  
*C. M. Loucks, W. B. Brown*
- 168 *Test Your C E Q* *R. Lemlich*
- 168 *Nomograph Gives Reaction Time or Reactor Size* *H. B. Kendall*
- 170 *Filter Prevents Blackened Lead Welds* *S. Harel*
- 170 *Zinc Dust Improves Polyethylene Coatings* *N. E. Wilson*
- 172 *Device Takes Samples During Lab Reaction* *R. J. Johnson*
- 172 *Simple Method Proves Multiplication* *G. J. Caras*
- 174 CE COST FILE *R. V. Hughson*
- 174 *Cost-Capacity Data III* *J. M. Berk, J. E. Haselbarth*
- 180 CORROSION FORUM *R. B. Norden*
- 180 *Corrosion-Resistant Hose: Where Does Teflon Fit In?*  
*E. M. Ramberg*

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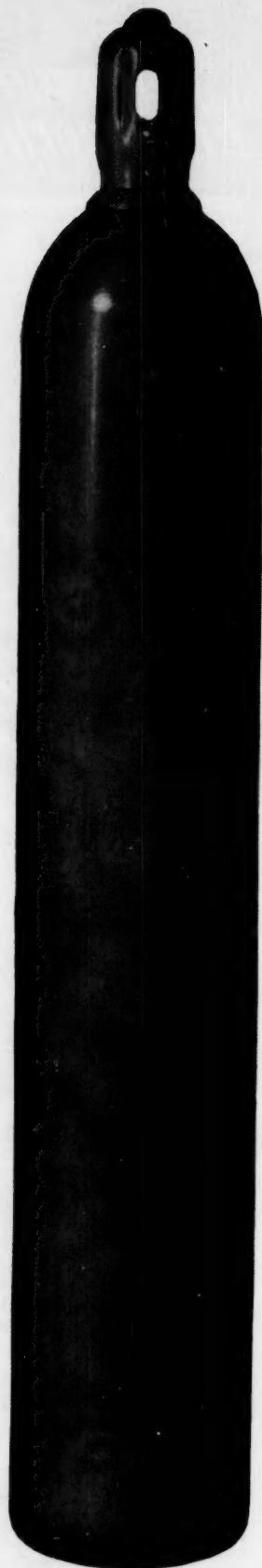
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## *highlights of this issue*

### **GUIDEPOSTS FOR YOUR THINKING AND PLANNING**

Year-end forecasts of '61 business are almost universally "cautiously optimistic." Our sampling of opinions in key process industries (p. 82) confirms the optimism. Consensus is that sales will gain. But estimates are cautious when it comes to how much. One facet of CPI technology, however, is bright in its readiness. Cryogenics has a large growth potential and we've recorded for you some facts from authorities who should have the answers to what cryogenics looks like as a business proposition (p. 94).

### **RECOGNITION OF ENGINEERING GROUP EFFORT**

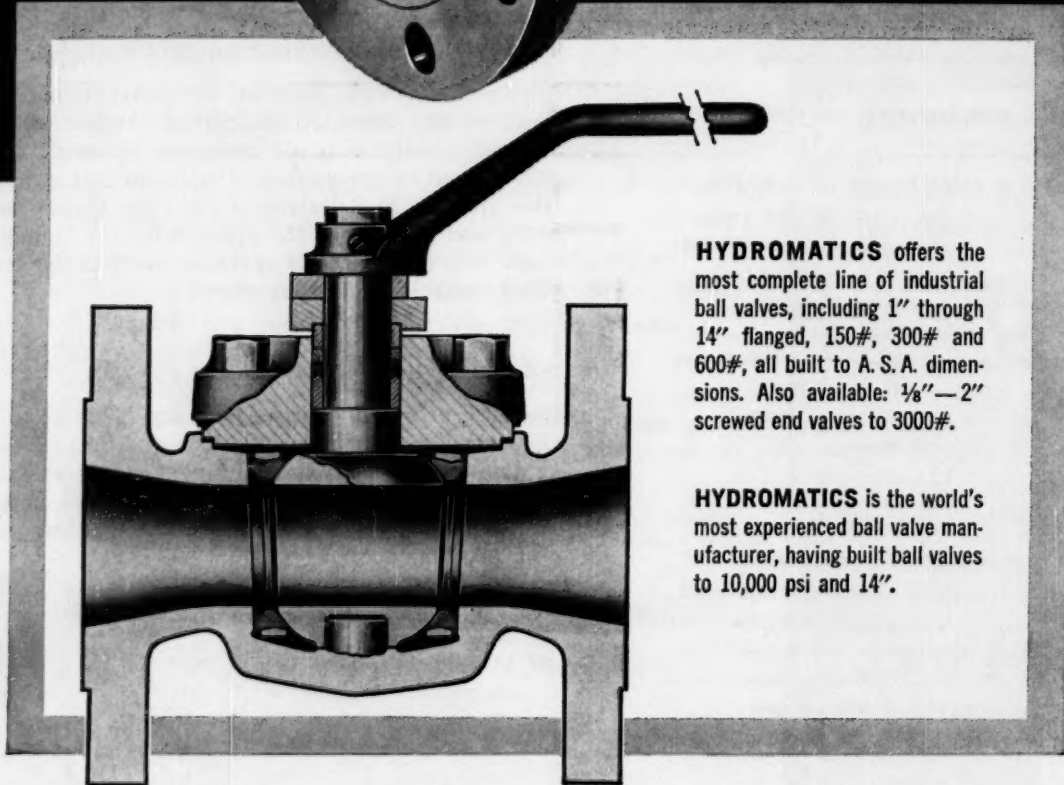
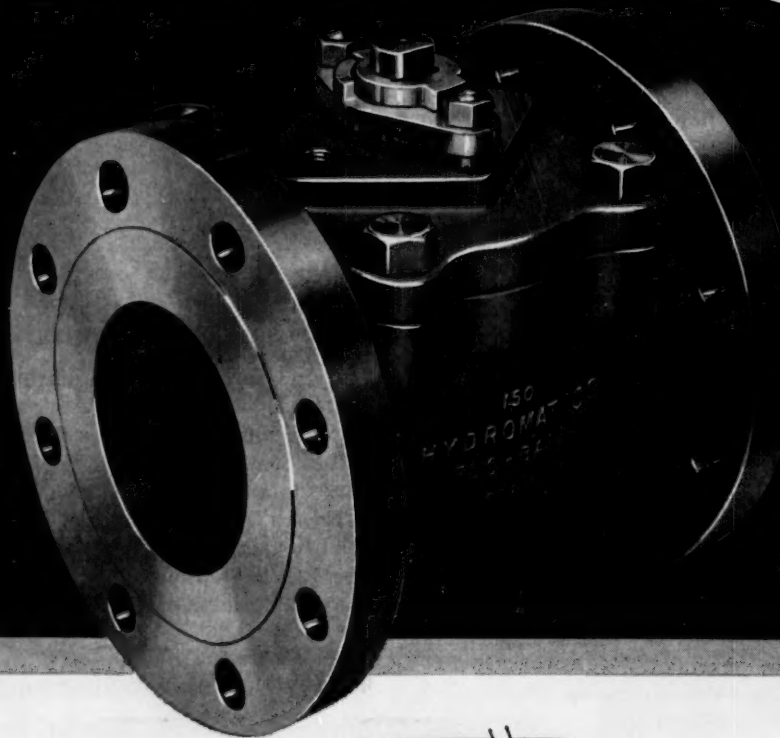
Nominations are now in order. Get yours in soon. Chemical Engineering's Biennial Kirkpatrick Award will be made again this year and it will recognize, as usual, outstanding achievement by some company in the chemical process industries (p. 84). Modification of the rules makes nomination easier and establishes the opportunity for honorable mentions. Who is your choice as the recipient of this long-established recognition of group effort?

### **DOUBLE DIVIDENDS FROM NOISE CONTROL**

Chemical process industries have far fewer noise problems than most industrial installations (p. 127). Nevertheless recognition and control of unwanted clamor will pay double dividends. You'll not only improve employee efficiency and effectiveness, but you'll also be a better neighbor—wherever your plant may be.



# How to buy



**HYDROMATICS** offers the most complete line of industrial ball valves, including 1" through 14" flanged, 150#, 300# and 600#, all built to A. S. A. dimensions. Also available: 1/8" — 2" screwed end valves to 3000#.

**HYDROMATICS** is the world's most experienced ball valve manufacturer, having built ball valves to 10,000 psi and 14".

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1. TOP ENTRY	✓			✓		
2. IN-LINE MAINTENANCE	✓			✓	✓	
3. TOP AND BOTTOM GUIDED BALL	✓					
4. DOUBLE SEATS	✓	✓	✓	✓	✓	✓
5. FLANGES INTEGRAL WITH BODY	✓	✓		✓		
6. ONE-PIECE BALL AND STEM	✓					
7. BLOCK AND BLEED	✓					
8. COMPETITIVELY PRICED	✓	✓	✓		✓	✓

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In addition to these outstanding features, the **FLO•BALL** valve, with all teflon seats and seals, offers all of these advantages which make it far superior to other types of valves: fast ¼ turn, minimum pressure drop, leakproof shut-off, visible on-off indication, no backlash, and the lowest torque of any valve. The **FLO•BALL** can never stick or freeze, and it lasts longer, with less maintenance, than any other valve made.

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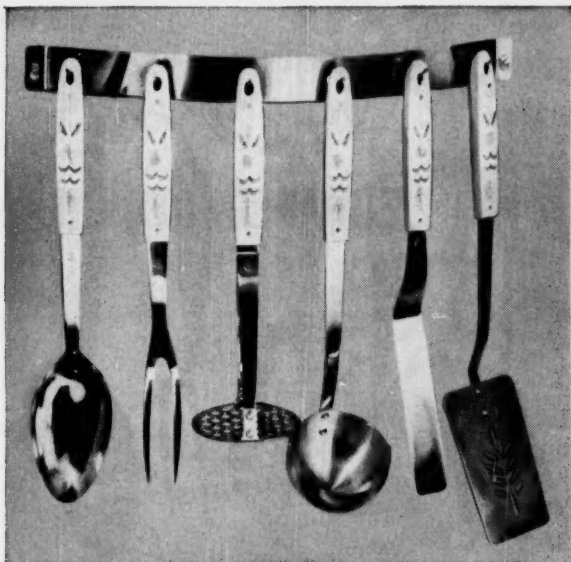


**CYANAMID**

# Chemical Newsfront



**FOR THE FIRST TIME—PERMEABILITY DATA FOR CYANOGUM® GEL.** The photo shows some of the well-known advantages of Cyanamid's CYANOGUM 41 gels: flexibility, ease of forming the gel, and rapid curing—only seconds at room temperature. Now, specific data are available to permit comparison of the CYANOGUM system's permeability with that of other well-known gels—viz agar, gelatin and silica. Are you interested in permeability coefficient and average pore size as a function of polymer concentration and deductions about the mechanism of transport in the gel? A copy of the article containing fundamental data on permeability recently printed in the *Journal of Physical Chemistry* is available to you on request. Check the appropriate area on the coupon. (Market Development Department)



**DECORATED MELAMINE HANDLES—A FIRST FOR FLINT.** Molded CYMEL® 1077 melamine handles with beautiful decorations are now part of EKCO Products Company's Flint Cook and Serve Tools. A melamine impregnated decorative overlay becomes a permanent part of the contour handles, which are wearproof and washable.

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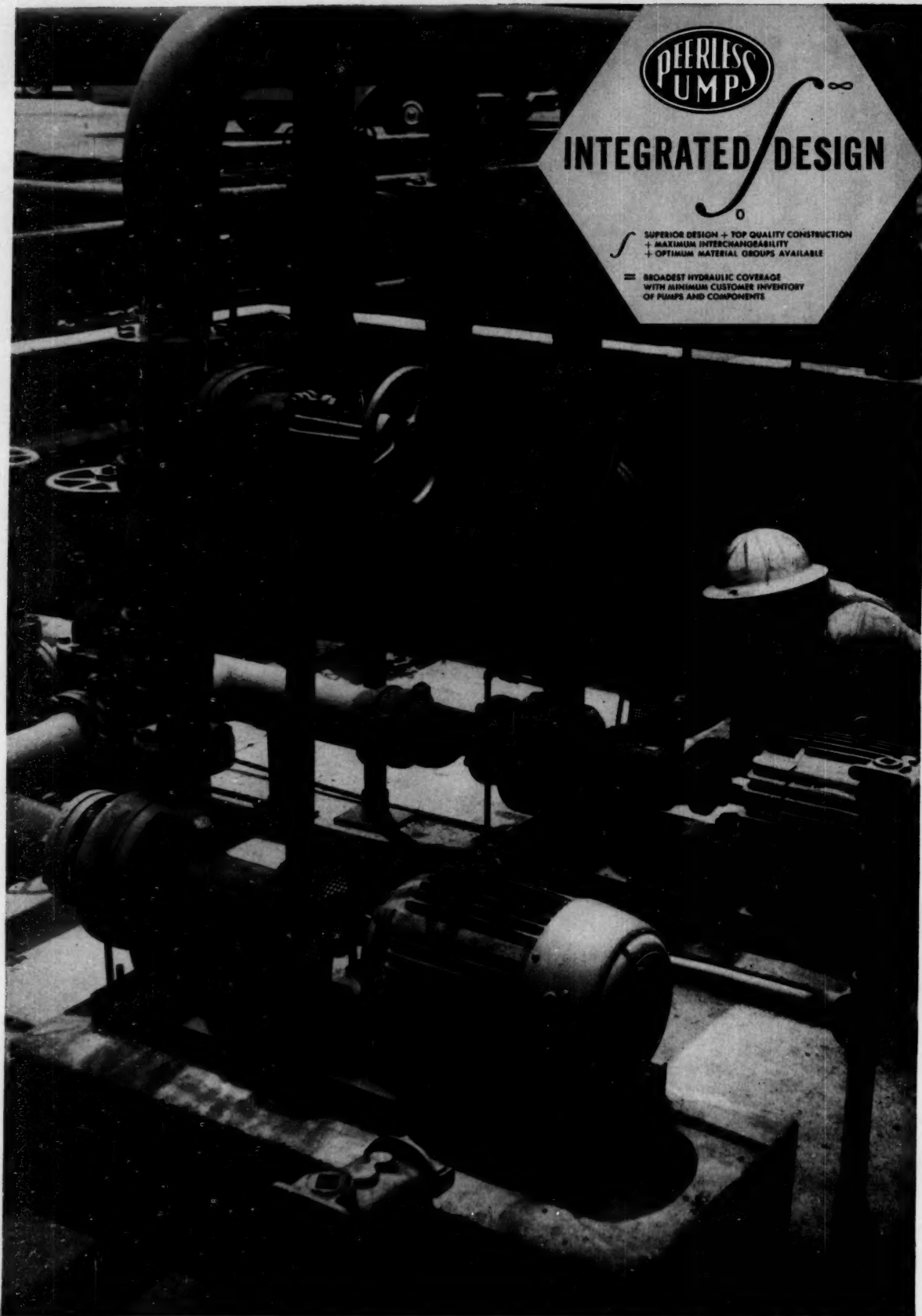
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# CAN CUT YOUR PUMP INVENTORY COSTS AS MUCH AS 85%

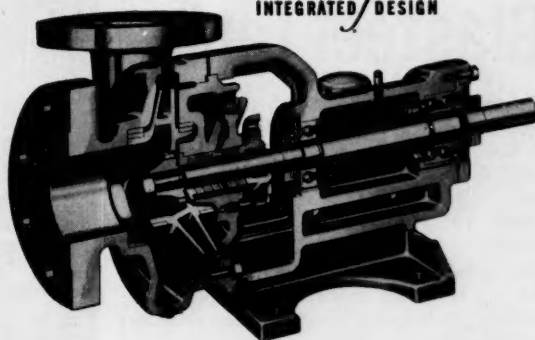
*Maximum interchangeability means far fewer parts required to fill all your day-to-day needs.*

The effectiveness of integrated design of Peerless Type DL and DM process pumps can probably best be shown by a recent customer's order. This customer purchased 150 process pumps for his plant. Of the group, 120 have interchangeable parts. As a result, pump inventory of spare parts can now be cut to a fraction of former requirements freeing important dollars for many other uses. And with the greater interchangeability, the customer predicts even more savings because of speedier maintenance work and less time lost waiting for proper parts.

And, if interchangeability of Peerless Type DL and DM pumps captures your interest, please remember this fact. Because Type DL and DM pumps are of integrated design, you can order them out of stock just the way you need them. For example, there is a choice of semi-open or enclosed impellers; water or air cooled backplates; oil or grease lube bearing housing; packing or mechanical seals; and liquid ends of any machineable metal.

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INTEGRATED DESIGN



## VERSATILE IS THE WORD FOR THIS PEERLESS DL-DM PROCESS PUMP

The Peerless Type DL and Type DM process pumps will handle virtually all liquids used in the chemical, process and refining industries. Both models are single stage, single suction centrifugal types with a vertically split case, and both models have capacities to 1000 gpm, heads to 430 feet and working pressures to 300 psig. Type DL models have a temperature range of 250°F, while the Type DM models have a range of 450°F.

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| 2. Back plate            | 14. Lockwasher-bearing        |
| 3. Packing rings         | 15. Gasket-volute case        |
| 4. Radial bearing        | 16. Gasket-thrust plate       |
| 5. Packing gland         | 17. Oil retainer plate        |
| 6. Thrust bearing        | 18. Oiler: constant level     |
| 7. Pump frame            | 19. Lockwasher-impeller       |
| 8. Impeller lock nut     | 20. Gland clamp               |
| 9. Bearing lock nut      | 21. Splash plate              |
| 10. Seal lantern packing | 22. Retaining ring bearing    |
| 11. Key                  |                               |
| 12. Thrust plate         |                               |



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# FLUIDICS\* AT WORK

## BIG Glasteel Tanks

This agitated tank is 35 feet high, weighs 10 tons and has a capacity of 17,000 gallons.

The construction is Pfaudler® Glasteel—glass inside, for corrosion resistance; steel outside, for strength. It costs *less* than you would pay for a stainless tank of equal capacity.

**You name the size.** Admittedly, tanks like this are not standard items. Yet, we can and will deliver Glasteel in vessels sized and designed to fit your needs.

For example, we recently supplied a 7,150-gallon reactor for processing monochloroacetic acid and alcohol at 158° F., with jacket designed for 25 psi pressure at 350° F.

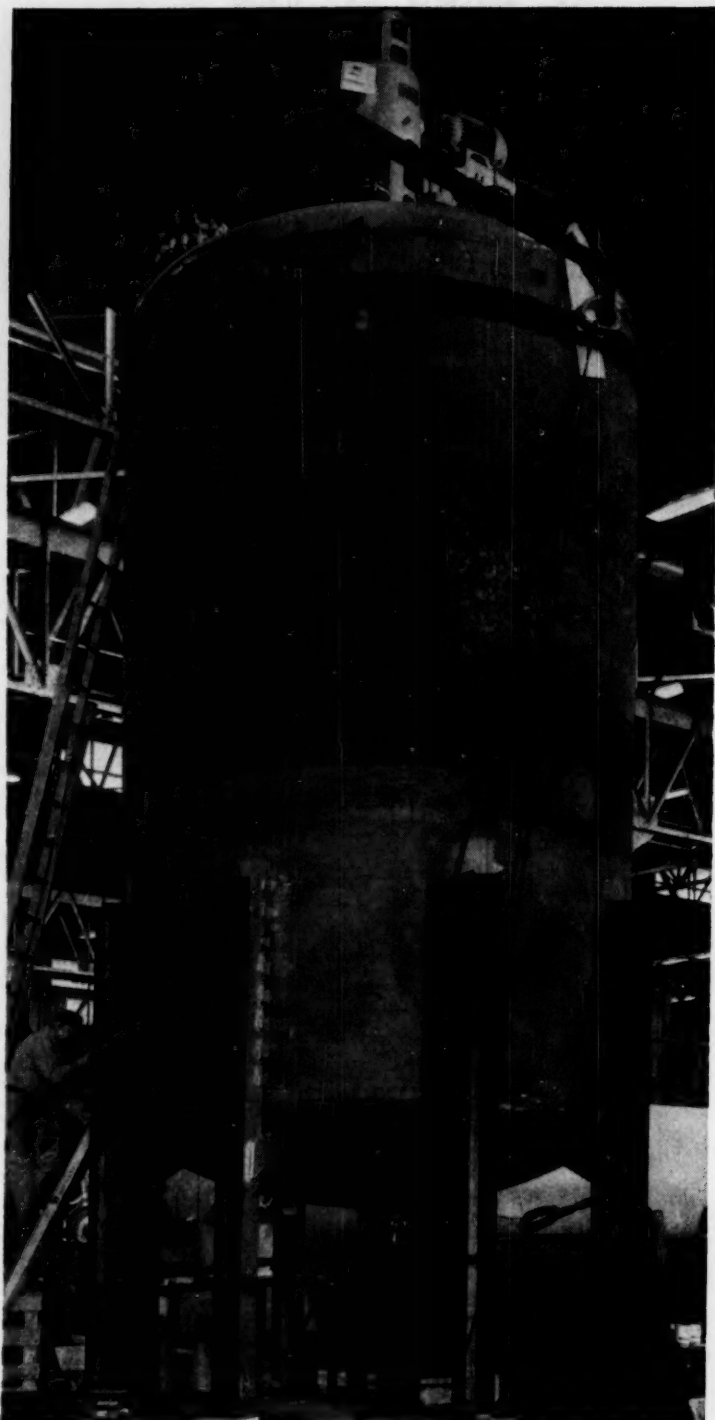
Then there are the really big 35,000-gallon Glasteel storage tanks, a very common sight on our production lines.

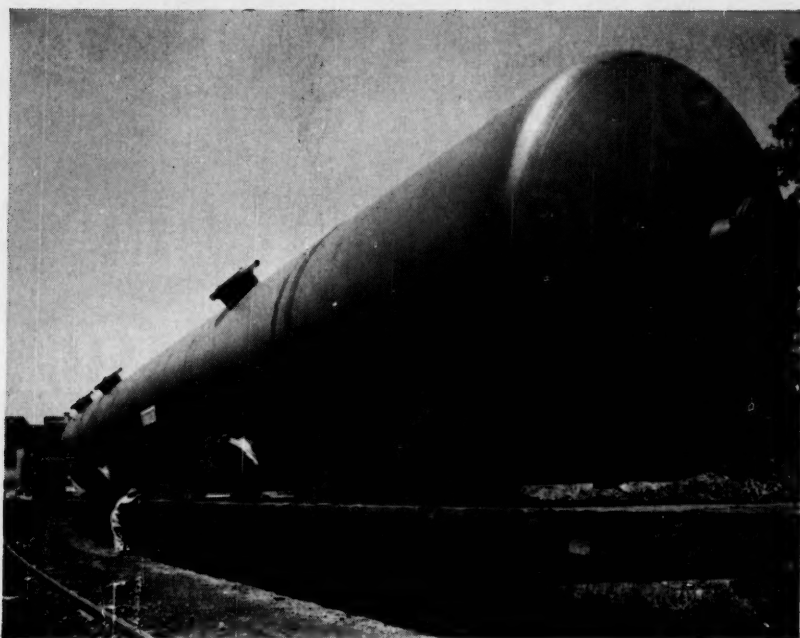
It takes special skills and facilities in fabrication to make such vessels. We welcome BIG ones. And, again, with Glasteel, big size actually means prices smaller than you pay for many other materials of construction.

**Protects purity.** The 17,000-gallon tank pictured will be used by The Borden Chemical Company for PVC production. Glasteel has become the *industry standard* for polymerization equipment, since it won't contaminate or discolor any of the materials used or produced. Nor will it act as a catalyst. This equipment is flexible, too, and can be changed from one polymer to another in tune with market trends.

**Reduced down time.** The surface of Glasteel is abrasion-resistant and smoother than the most highly polished metals. Very little adheres to it. What does you can quickly wash away between batches. Result: more output of product per day than with other materials.

**Facts for your files.** Bulletin 932 covers Pfaudler Polymerizers. Bulletin 975 details the economies of and specifications for Glasteel Storage. We'd be happy to send copies or answer questions about BIG Glasteel tanks. Write to the address shown on the facing page.





## We may never build a column like this again

What you see on these two flatcars is a stainless-clad nitrite column, 11 feet in diameter, 76 feet long, and 43 tons heavy.

We built it to these extraordinary specifications for a good reason—it was exactly the size required to do the job.

And it may be that neither you (nor anyone else) will ever need a column identical to this again. For example, you may require a *smaller* size. That's fine, since we make columns with I.D.'s as small as 2 inches.

Your requirements may dictate a *different* material of construction. That's fine, too, since we fabricate from a wide assortment of corrosion-resistant materials, including nickel alloys, clad metals, and

the refractory metals, as well as Glasteel.

Of course, *design* is also matched to your processing requirements. Choose from packing supports and distributor trays; bubble cap, sieve and turbogrid internals. Sizes range from 2-inch to 12-foot diameters with lengths only limited by shipping requirements.

Selecting a column obviously requires balancing many factors—cost, corrosion resistance, capacity, handling and cleaning, pressure drop, and load efficiency. Our project engineers will gladly bring their experience to bear on your column requirements. Bulletin 940 details many of the basic facts. Or drop us a note outlining your problem.

### NEW BULLETIN—Glasteel, the Material of Construction

Just off the press is our four-color Bulletin 985, documenting the characteristics of Glasteel 59.

Of its 20 pages, 16 are devoted to *technical data* on specifications, thermal shock, operating temperatures, heat transfer, alkali resistance, acid resistance, and corrosion evaluation facilities.

This is the first time all pertinent data on Glasteel have been brought together in a single brochure. The results are impressive.

Quite possibly, this brochure will suggest ways in which you can put this material of construction to use—reducing costs, improving service life of equipment, protecting product purity.

We think you'll find Bulletin 985 a worthwhile addition to your file. Write for your **FREE** copy.



## Cut to order... F-C Glasteel pipe†

Immediate delivery is what you can get when you need odd-size lengths of a corrosion-resistant, high-integrity lined pipe in lengths to 10 feet. That's the availability story on F-C pipe when ordered to size from our factory.

**Do it yourself.** The F-C means "field cut" and also means you can do it in your own plant with almost any standard dry-abrasive cutoff wheel. After that it's a simple matter of threading, fire-polishing (using a small, portable furnace available from Pfaudler) and finishing with a belt sander.



**Corrosion resistant.** Glass lining for this pipe is 1/8 inch thick, so you can expect substantially long service life even with corrosive and/or abrasive fluids. Rated at 150 psi, F-C pipe is available in 1 1/2, 2 and 3-inch diameters. Use it with all acids (except HF) to 350°F., and with all mild alkalis at moderate temperatures.

**No contamination.** Also, since glass is *inert*, you can use this pipe with products that must be kept free from contamination. And because it's *smooth*, there's little chance for build-up, even with sticky materials.

Remember: It's "off-the-shelf" for F-C pipe in any length to 10 feet.

†Patent applied for

Please address all inquiries to our Pfaudler Division, Dept. CE-21, Rochester 3, N. Y.

\*FLUIDICS is the Pfaudler Permutit program that integrates knowledge, equipment and experience in solving problems involving fluids.




**PFAUDLER PERMUTIT INC.**

Specialists in FLUIDICS . . . the science of fluid processes

*How complex is your drying problem?*

# YOUR VACUUM DRYING REQUIREMENTS GET "CUSTOMIZED" HANDLING AT STOKES

A black and white photograph showing a worker in a light-colored, short-sleeved shirt standing in front of a large, dark, cylindrical industrial machine. The worker is holding a small object, possibly a tool or a sample, and appears to be inspecting or operating the machine. The machine has a curved, metallic surface with some visible rivets or bolts. The background is dark and indistinct.

The rotary vacuum dryer shown here is drying tonnage quantities of a chemical salt. This type of dryer is ideal for drying such critical materials as dyes, flocculants, fungicides, insecticides plus organic and inorganic salts. Stokes manufactures a complete line of vacuum drying equipment.

Conical Vacuum Dryer shown below in Stokes laboratory is being used for a variety of tests on customer products.



**P**ROCESSING tonnage quantities of materials in an inadequate vacuum dryer can be time consuming and costly. That's why Stokes experienced vacuum engineers study each drying requirement individually . . . then design the drying system to meet your specific needs. Drying systems in capacities from a few pounds to several tons are available . . . along with application engineering, laboratory service and pilot plant operations. Stokes puts its 50 years of vacuum processing experience to work on every drying problem . . . bringing you both money-saving and quality results. What's more, Stokes manufactures all its own pumps and accessories to assure you one-manufacturer responsibility in addition to unparalleled vacuum know-how.

Stokes will thoroughly explore your production problems . . . make recommendations on the basis of a practical knowledge of process operations . . . and confirm the recommended equipment by actual pilot plant production in the Stokes laboratory, if necessary.

Our representative in your area will initiate Stokes action to assure the best answer to your drying problem. Why not call him soon? Or if you prefer, write for new summary booklet on drying applications.

# **STOKES**

*Processing Equipment Division*

**F. J. STOKES CORPORATION**

*5500 Tabor Road, Philadelphia 20, Pa.*



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WATER WELL SUPPLIES



CONDUIT



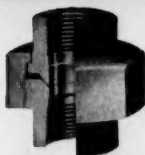
UNIONS



TUBING



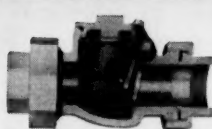
**HOT FORGED STEEL HIGH-PRESSURE UNIONS AND VALVES**



**"PETRO" CARBON  
STEEL UNION**



**PETRO" STAINLESS  
STEEL UNION**



**SWING  
CHECK VALVE**



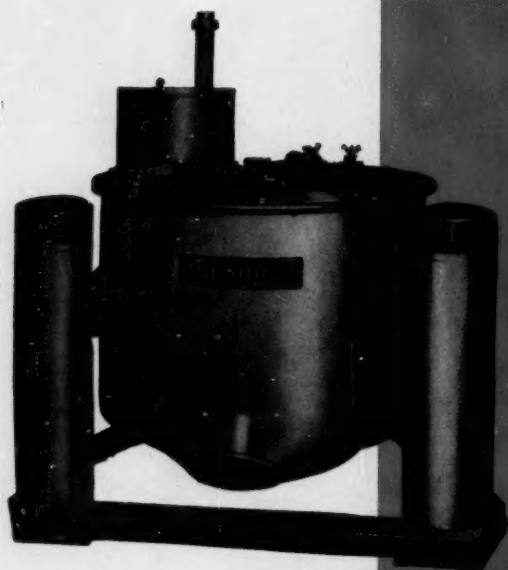
**"PETRO"  
CHECK VALVE**



**"BEVELED"  
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# *Specialists in* Liquid-

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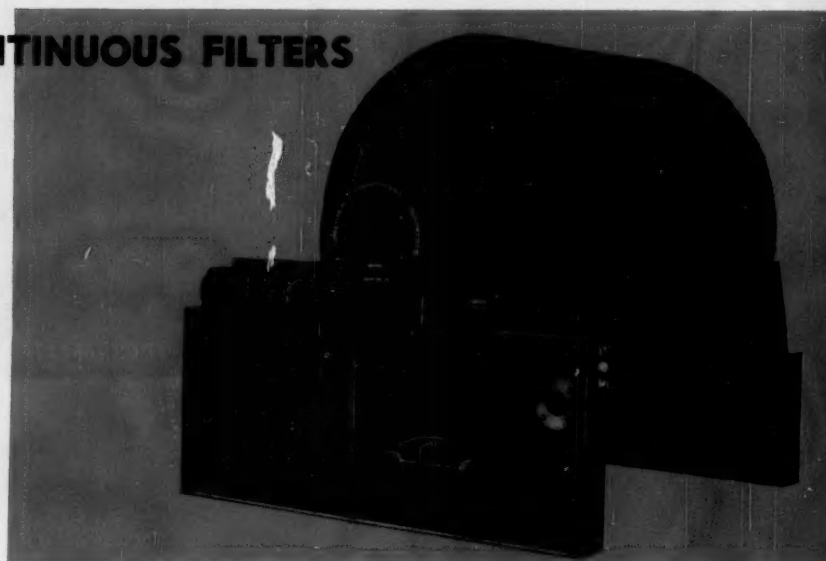
### CENTRIFUGALS

- BATCH-O-MATIC®
- BATCH-MASTER®
- SUSPENDED
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- CONTINUOUS

## **FE INC**® CONTINUOUS FILTERS

*Custom Engineered*

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OR  
PRESSURE  
ROTARY DRUM
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- PRECOAT



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PLETE UNBIASED SERVICE

## Niagara<sup>®</sup> FILTERS



- **VERTICAL LEAF MODELS** in both horizontal and vertical tank designs.
- **BATCH-MISER<sup>®</sup>** horizontal plate models for polish filtration and batch operations.
- **MEET ASME Code** Construction requirements

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Available by the roll or tailored to fit all types of fluid/solid separation process equipment.

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FEON Woven Textile Fiber Fabrics  
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EAST MOLINE, ILLINOIS

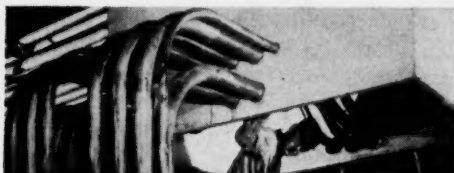
DIVISIONS OF AMERICAN MACHINE AND METALS, INC. TROY LAUNDRY MACHINERY • RIEHLE TESTING MACHINES • DEBOTHREAT FANS • TOLMURST CENTRIFUGALS • FILTRATION ENGINEERS • FILTRATION FABRICS • NIAGARA FILTERS • UNITED STATES GAUGE • BANG INSTRUMENTS • LANG ELECTRIC COMPANY • HUNTER SPRING COMPANY • GLASSER-STEIN CORPORATION





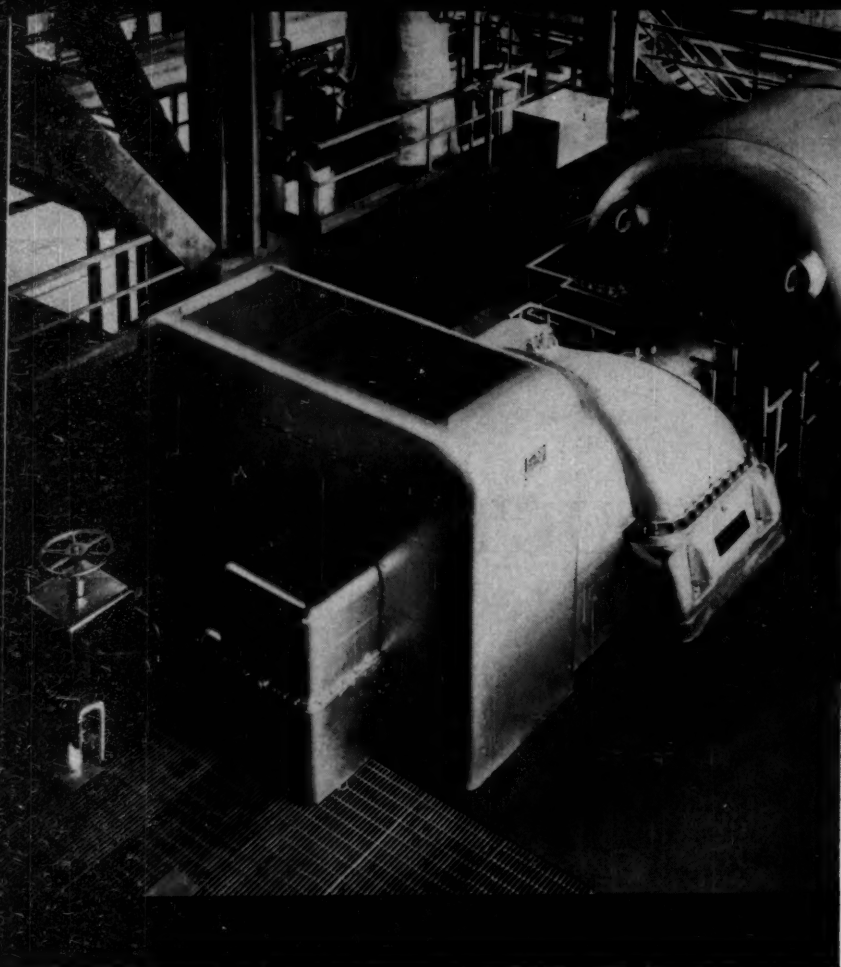
## Where **PRODUCT PURITY** is important, protection gets a hand from Alcoa

When protection against contamination from *any* source is vital, take a look at what Alcoa aluminum electrical rigid conduit offers. ¶ It needs *no* protective coating, because it forms its own—an oxide film that repairs itself when damaged. ¶ It's corrosion-resistant—stands up particularly well against acids commonly present in food plants: citric, acetic, tannic. And the compounds that might form when aluminum is used are in most cases *nontoxic*, completely safe. ¶ What else? Aluminum is lightweight (weighs about 1/3 as much as steel), so it's easier to install. Alcoa conduit is also non-magnetic, nonsparking, and neat appearing. ¶ Consider all costs—initial, installation, maintenance—plus long service and you'll see why Alcoa aluminum conduit is a sound investment. ¶ For full details, contact one of our nearby representatives. Or write to Rome Cable Division of Alcoa, Dept. 22-21, Rome, New York.



◀ **ADDED PROTECTION** against product contamination is provided by Alcoa aluminum conduit. It needs no protective coating, resists corrosion, and is nontoxic.

**ROME CABLE  
DIVISION OF ALCOA**



This Elliott integrated compressor unit consists of a multistage compressor rated 135,000 inlet cfm, with its 12,440-hp turbine.

Elliott compressors are made in capacities of 500 cfm to 600,000 cfm. The cutaway view of a multistage unit, below, shows the welded, closed impellers and rugged casing.



## Demands of large FCC unit prove excellence of Elliott Turbine-Compressor

For over six years, the machine shown above has kept things moving through a 40,000-barrel-per-day fluid catalytic cracking unit in Texas. Said to be the largest of its kind when installed in 1953, it serves the catalyst circulating and regenerating system of the refinery unit as efficiently today as it did the day it was installed.

Elliott offers the most complete line of well-established centrifugal and axial flow compressors for gas and air—with matching Elliott motor or turbine drives. There are 48 compressor frame sizes, providing excellent choice for

all applications over the entire range of capacities from 500 cfm to 600,000 cfm.

Since the drive represents half of any compressor installation, the unified design inherent in these driver-compressor combinations assures greatest satisfaction. Elliott turbines and motors are made in a wide range of sizes, types and ratings, assuring ample choice for all applications.

For further information, consult nearest Elliott office, or Compressor Department, Elliott Co., Jeannette, Penna.

**ELLIOTT** THE MOST COMPLETE LINE OF  
**INTEGRATED COMPRESSOR**  
**& DRIVER UNITS** 500 cfm to  
600,000 cfm



**ELLIOTT COMPANY**

GENERAL OFFICES: JEANNETTE, PENNSYLVANIA

PLANTS AT: Jeannette and Ridgway, Pa.; Springfield, Ohio; Newark, N. J.

TURBINES • GENERATORS • MOTORS • COMPRESSORS • TURBOCHARGERS

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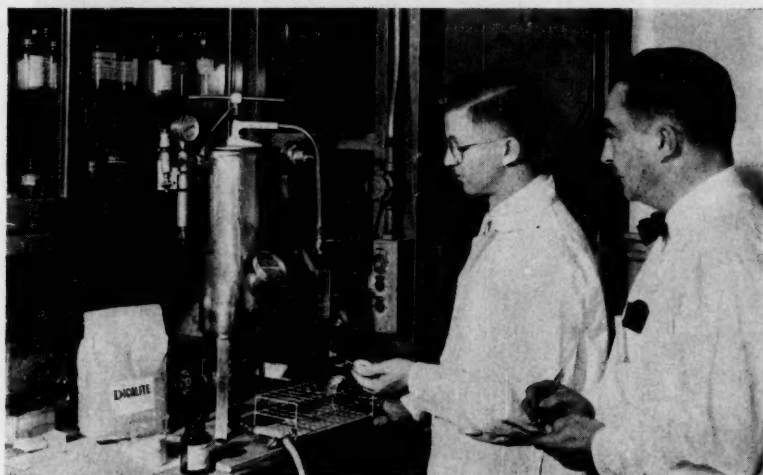
PO-2

# DICALITE®

## TECHNICAL REPORT

DICALITE DEPARTMENT • GREAT LAKES CARBON CORPORATION • 612 SO. FLOWER ST., LOS ANGELES 17, CALIFORNIA

### Why Antibiotics Producers Filter with Dicalite



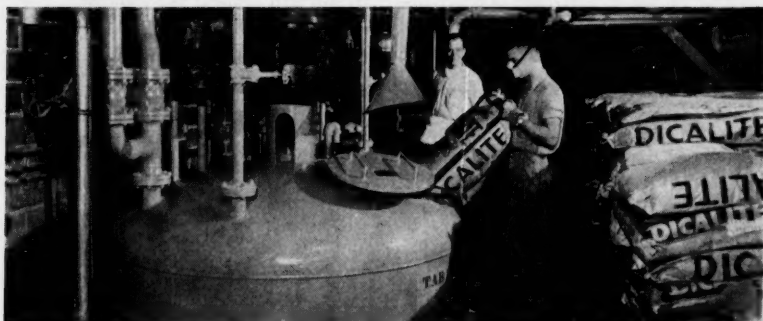
Dicalite Filteraids meet two major requirements in antibiotics production—(1) large volumes of fluid must be filtered, and (2) exceptional purity is required in the final product. Thus, they have long been used by many producers of penicillin, aureomycin, streptomycin and other drugs.

The consistent uniformity in each of the many Dicalite diatomite and perlite filteraids is an important factor, since it provides known performance characteristics in these critical processes.

Dicalite's new perlite filteraids are remarkably efficient in handling high

solids content fluids, and provide high resistance to cake cracking in rotary vacuum precoat filtration, extensively used in pharmaceutical processing. Because of their light weight, Dicalite perlite filteraids give up to 25% greater filtering capacity per pound, resulting in savings in filteraid usage of 20 to 30%. They are available in a complete range of grades.

Dicalite technical service engineers will be happy to advise with you on the application of Dicalite filteraids to your individual needs in filtering any type of liquid.



At the Cherokee Plant of Merck & Co., Inc. at Danville, Penna., Dicalite is being used to aid the filtration of an antibiotic fermentation broth.

© 1961 GREAT LAKES CARBON CORPORATION • LOS ANGELES, CALIF.

Roger W. Hess



Dicalite's  
"Man On The Spot"

Working on filtration problems with customers' technicians in their laboratories is nothing new to Roger Hess, shown at left checking flowrate in a filtration test in a Merck laboratory, for Roger is a veteran of more than 25 years in the filtration field. Included were 12 years work with filter manufacturers, leading him to his present role of filteraid engineer. His interest in his work is indicated by the title of one of the papers he has contributed to chemical publications — "Filtration In My Blood."

Graduating from Brooklyn Polytechnic Institute with a degree in Chemical Engineering, Hess spent several years with chemical equipment manufacturers before getting into the specialized area of filtration. He counts 3 years laboratory work as being especially important in his present work. A member of the honorary fraternity, Phi Lambda Upsilon, he is active also in the American Chemical Society, the American Institute of Chemical Engineers, the Baltimore Chemical Club, and other technical societies in the paint, brewing, electroplating and chemical fields.

#### TECHNICAL LITERATURE

on Dicalite Filteraids is available on request. Bulletin B-14 discusses the principles and operating practices of filteraid filtration, and its applications in many industries.

Write for your copy to:

Dicalite Department  
612 So. Flower Street  
Los Angeles 17, California



*Battery of Cowles Dissolvers which pre-mix material preparatory to milling.*



*Morehouse Mills finish off products in one pass.*

**FAMOUS  
MANUFACTURER**

*Entrance of new, ultra modern plant of H. Blalock Printing Ink, Inc.*

*Harold Blalock, president, H. Blalock Printing Ink, Inc.*

**CUTS  
PROCESSING  
TIME  
FACTOR 50%  
WITH COWLES  
DISSOLVERS &  
MOREHOUSE  
MILLS**

Anthony Espelage, Manager Flexo Department,  
Reports on Important Savings and Economies:

"Our new plant, just completed, has been planned for higher efficiency, with finest equipment and facilities.

"We manufacture Gravure and Flexograph inks and paper coatings on our Morehouse and Cowles equipment. Material is pre-mixed on the Cowles Dissolvers and then completed in one pass through the Morehouse Mills, as compared to two passes with material from previously used mixers. Approximately 50% of milling time is saved and plant capacity greatly increased. Initial costs and maintenance expenses of the system are relatively low.

"Its great versatility and ability to handle a wide variety of formulations, especially with regard to viscosities, is extremely important to us, enabling us to plan our production with the very minimum in labor costs. When an elevated platform is used, one man can run several Morehouse Mills while other batches are being pre-mixed on Cowles Dissolvers.

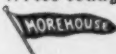
"Results are very satisfactory, with end products of highest quality.

"We are very glad to be able to make the above statements."

This is another important example of the way Morehouse Mills and Cowles Dissolvers produce more, in less space, at less cost—and produce it better. If you have comparable processing requirements, they will give you the same kind of results on your products.

**LET US PROVE IT...IN YOUR PLANT...AT OUR RISK!**

*Write today for more complete information...*



**MOREHOUSE-COWLES, Inc.**



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616

REPRESENTATIVES IN PRINCIPAL CITIES • CONVENIENT LEASE AND TIME PAYMENT PLANS

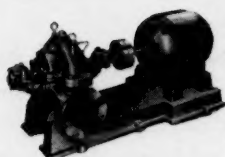


# MULTIPLY ECONOMY by

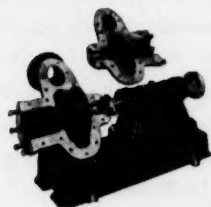
# 5

When You Install  
Buffalo Pumps

- 1** Maximum parts interchangeability reduces inventory costs.
- 2** Emphasis on quality insures extra years of economical, productive service.
- 3** Peak hydraulic efficiency insures lower operating costs.
- 4** Sturdy, extra-heavy construction means trouble-free performance.
- 5** Complete Buffalo line gives one-source buying.



**Clear Water Pumps.** For peak efficiency in clear water service. Highest quality construction assures long, maintenance-free life. Write for Bulletin 955.



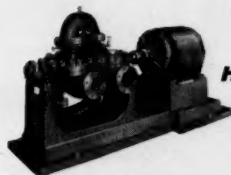
**Non-Clogging Pumps.** Efficiently move high consistency liquids. The diagonally split shell gives easy access for inspection. Rubber-lined models for moving abrasive or corrosive liquids. Send for Bulletin 953.



**Heat Transfer Pumps.** Specially designed to handle high temperature liquids. Construction includes required alloys, water-cooled bearings and packings suited to the job. High-efficiency single suction, solid shell design. Write for full information.



**Chemical Liquid Pumps.** These specially designed pumps stand up under the severest service, handle most types of corrosive or abrasive liquids. Choose from numerous models in exactly the trim you need. Send for Bulletin 976.



**High Pressure Pumps.** Designed for boiler feed and other clear water installations. These rugged pumps assure peak efficiency, minimum downtime and long life. Operate against heads to 1500 ft. Capacities to 900 gpm. For complete details request Bulletin 980.



**Close-Coupled Pumps.** Save space without sacrificing efficiency. Installation is simplified, no need for shaft alignment. Vertical or horizontal installation. Discharge adjustable to desired angle. Send for Bulletin 975.

Helping you select the pumps that will serve you best and most economically is your Buffalo Representative's job. Contact him today, or write us for complete facts.



**BUFFALO PUMPS DIVISION  
BUFFALO FORGE COMPANY**

Buffalo, New York

Canada Pumps Ltd., Kitchener, Ontario



'Buffalo' Air Handling Equipment to move, heat, cool, dehumidify and clean air and other gases.




'Buffalo' Machine Tools to drill, punch, shear, bend, slit, notch and cope for production or plant maintenance.



'Buffalo' Centrifugal Pumps to handle most liquids and slurries under a variety of conditions.



Squier Machinery to process sugar cane, coffee and rice. Special processing machinery for chemicals.



## Corrosive HCl ... metered simply, accurately with the Foxboro Magnetic Meter

"Meter is completely corrosion proof," Cabot Carbon Company reports

When you're metering hydrochloric acid for billing to a customer — for a price — accurate measurement becomes important. But how can you get it with a liquid as corrosive as 33% HCl?

At the Cabot Carbon Company, Tuscola, Illinois, the Foxboro Magnetic Meter is the best answer. There's nothing to corrode or plug up — no flow restrictions of any type. Plus metering accuracy of better than  $\pm 1\%$ . An "impossible" measurement made simple, accurate, continuous.

If you have a difficult liquid in your plant, the Foxboro Magnetic Meter can pay off for you, too. Ask your Foxboro Field Engineer about it or write for Bulletin 20-14. The Foxboro Company, 362 Neponset Avenue, Foxboro, Massachusetts.

# FOXBORO

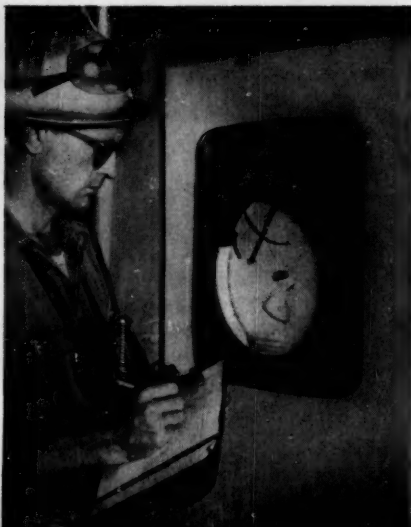
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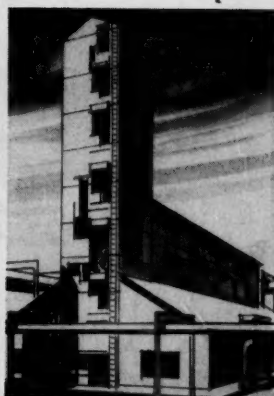
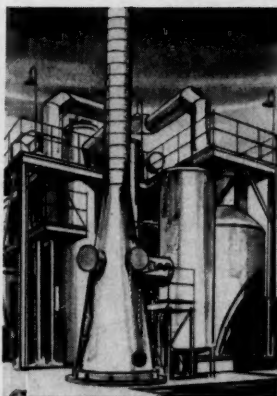
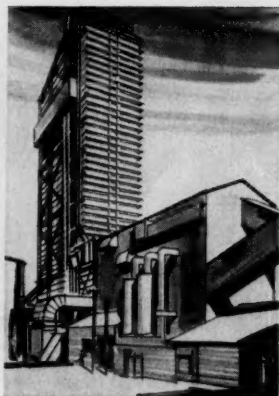
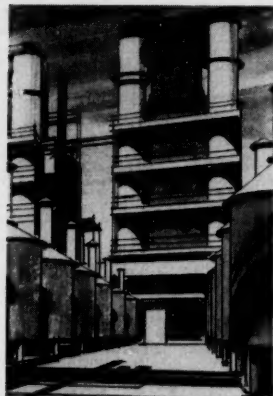
## MAGNETIC FLOW METERS

2" Foxboro Magnetic Meter measures 33% hydrochloric acid leaving the Cabot Carbon plant at Tuscola, Illinois. Meter has a Teflon lining, platinum electrodes — completely resists corrosion.

Foxboro Dynalog\* electronic recorder logs acid flow. Chart records are attached to customer's monthly invoice as proof of delivery.

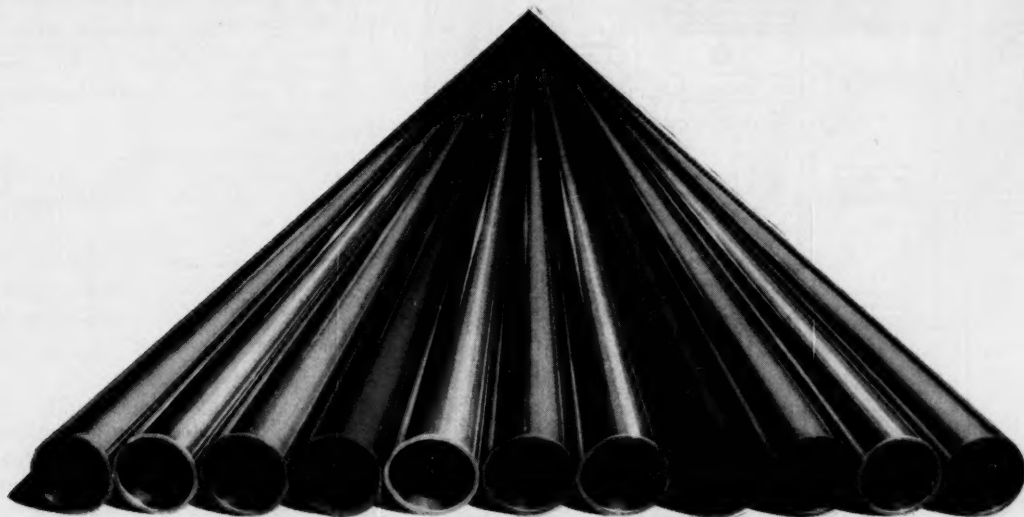
\*Reg. U.S. Pat. Off.





Need tubes for heat exchangers, condensers, evaporators, coolers,  
feed-water units?

## **PHELPS DODGE COPPER-BASE ALLOY TUBES have a reputation for reliable "On-Stream" Performance!**



■ Wide line of finest quality copper-base alloys for every kind of application need—including bi-metal combinations.

■ National warehouses, completely stocked, in Houston, Beaumont and Corpus Christi, Texas; Baton Rouge and Lake Charles, La., Tulsa, Los Angeles, and South Brunswick, N.J., to serve customers coast to coast.

■ Expert engineers to help you solve tube corrosion problems, select the exactly correct alloy for your applications.

Specify the best—at the same cost as the rest!

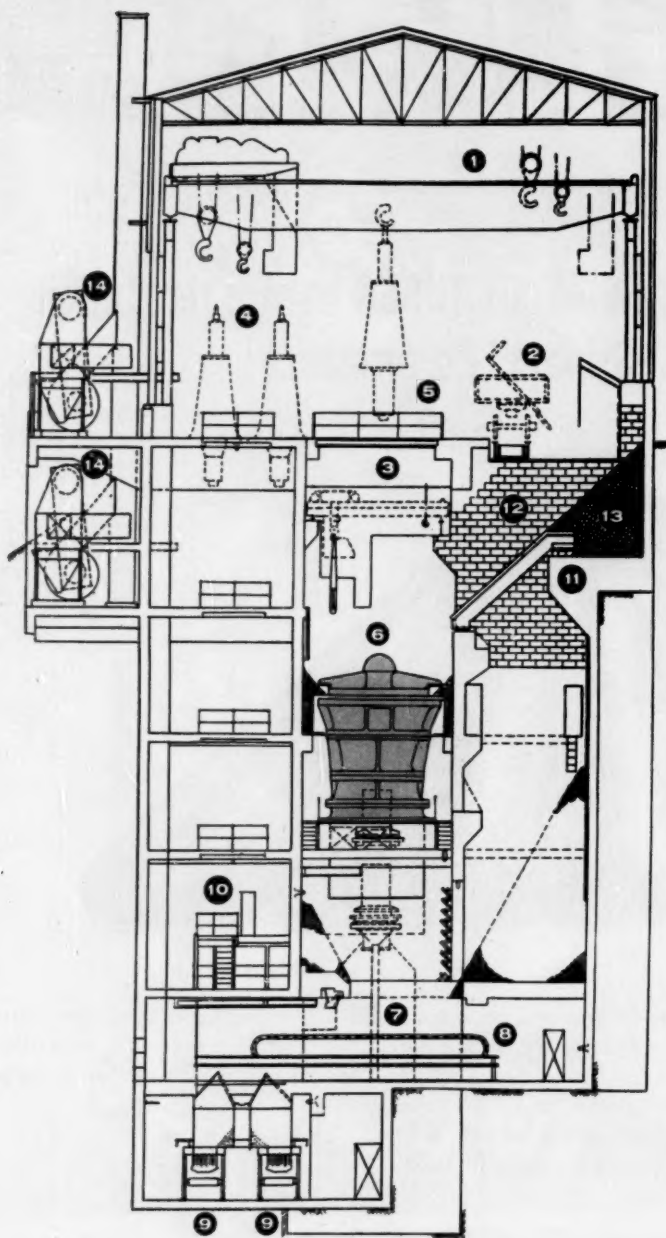
### **PHELPS DODGE COPPER PRODUCTS CORPORATION**

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**POUNDS OF TRAYLOR ENGINEERING!**



## TRAYLOR

**world's largest manufacturer of 60" gyratory crushers designed and built this plant for installation in Peru.**

The Southern Peru Copper Corporation called on Traylor-made **ECONOMY, EFFICIENCY, AND CAPACITY** to handle the tremendous crushing workload at its new plant in Toquepala, Peru.

Drawing shows Traylor 60" gyratory crusher operation:

1. 100-ton crane with 25-ton auxiliary hook and operator's cab
2. 43-cu. yd. side-dump mine car
3. 20-ton crane with rock hook
4. Mantle storage
5. 18 x 22-ft. removable hatch
6. 60-in. Traylor gyratory primary crusher
7. Hydraulic hoist, 14-ft. lift, 25-ton capacity
8. Two 72-in. pan feeders
9. Two 54-in. chain-belt conveyors
10. Electrical control panel
11. 8-in. grizzly
12. 2-in. plate liners
13. Dead-bed areas
14. Air filter dust removal unit

Other Traylor Crushers made for primary, secondary or fine reductions. Write today outlining your crushing requirements and let Traylor's engineers make recommendations . . . or ask for Bulletin No. 1126.



TCA-9

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## *Contour of Quality!*

In a Marley Class 600 Double-Flow tower, predetermined performance is as characteristic as its functionally angled profile. This new 30,000-g.p.m. tower is typical of a long list of *successfully tested* Class 600's that demonstrate why their contour is now accepted as the symbol of ability to meet or exceed specified cooling capability. Each year the list of these plus performance installations grows; each year the test list and test results are published as a public record.

The Class 600 contour also signifies other important design advantages: One of the most outstanding of these is the excellent balance of air volume and air velocity that permits largest capacity per fan cell. The end result is low required horsepower; less mechanical equipment; reduced maintenance cost. Further, the distinctive shape points up a high standard of durability established by liberal use of non-corrosive materials at critical points throughout Class 600 structure.

In a Class 600, quality and stamina are *evident* at a glance, *obvious* on careful examination. Evaluation amplifies the sum of these features as a value unequalled both for practical investment and for profitable plant operations.



**THE MARLEY COMPANY • KANSAS CITY MISSOURI**





60° Be SULPHURIC ACID  
Capacity 106,000 Gallons

U. S. STEEL reports:

**SMALL VALVE IN 4TH YEAR OF 'ROUND-THE-CLOCK' SERVICE !**

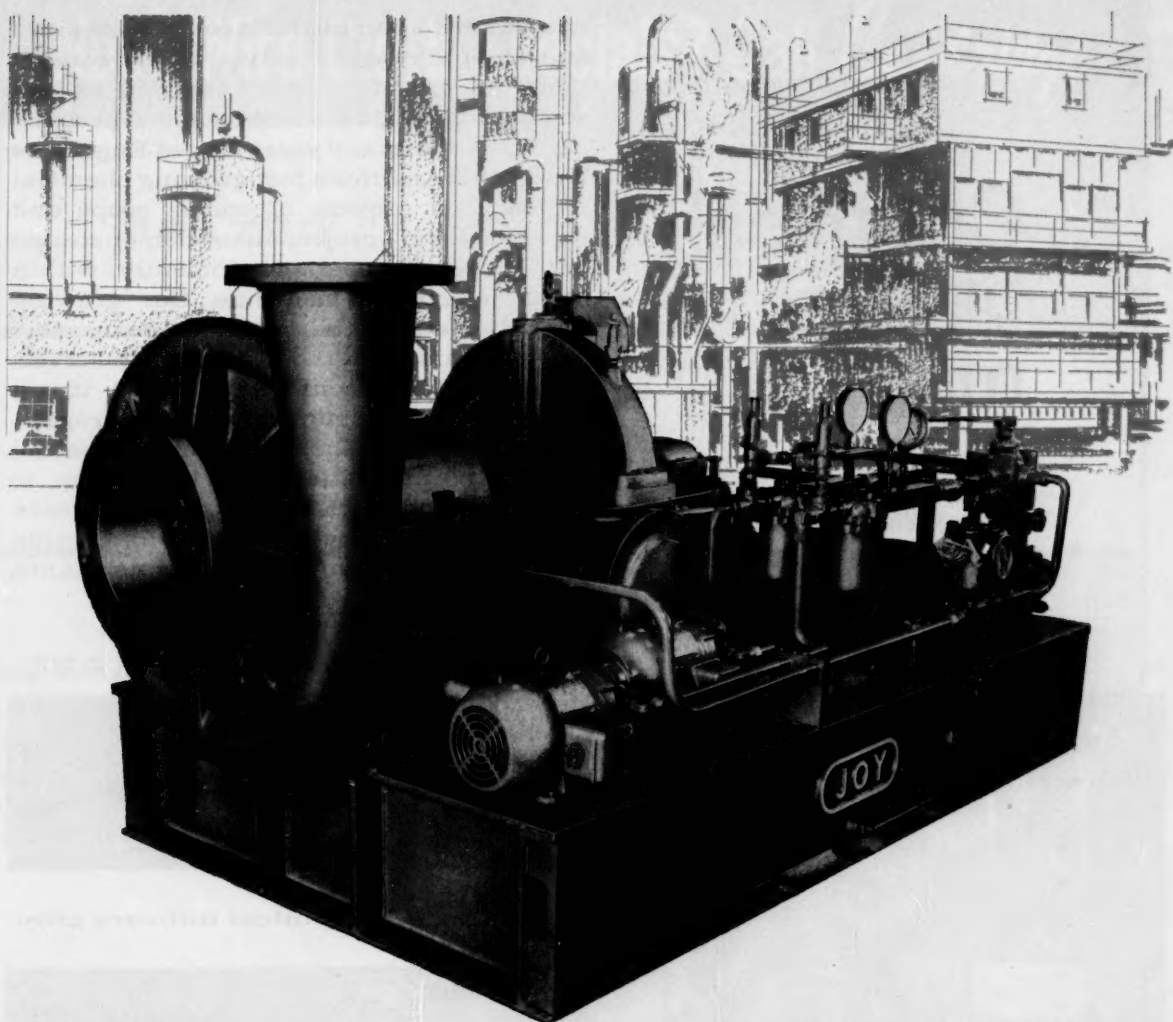
It guards the outlet of one of the world's largest acid tanks for U.S. Steel. Here are the performance facts on this 4" Aloyco Gate Valve (made of Aloyco 20 Stainless Steel): It still shuts off tight. It has required no servicing except for minor packing adjustment. It has been on continuous 24-hour service for 4 years. People who pay for performance only, rely on Aloyco Stainless Steel Valves wherever corrosion is a problem. Want a safe, economical way to handle corrosives? Write: Alloy Steel Products Co., Inc., 1301 West Elizabeth Ave., Linden, New Jersey. 03



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## JOY MODEL "G" SINGLE-STAGE CENTRIFUGAL COMPRESSORS PROVIDE THE UTMOST IN RELIABILITY

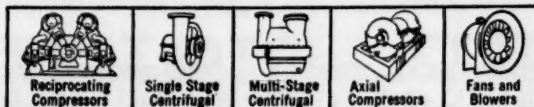
Joy Model G Single-Stage Centrifugal Compressors are designed and built to service continuous processes with the utmost reliability. They have a minimum number of bearings and no high speed couplings. Impellers are machined from a single piece of metal, and the entire compressor is ruggedly built.

Model G Compressors are not only reliable and maintenance-free, they also are highly efficient and very compact. They take less than half the space occupied by units of comparable output. Good aerodynamic design permits a reduction in scroll size,

and use of an integral gear further reduces size and weight of the unit. Compressor and drive are mounted on a single base plate.

Model G Compressors are available in 6 models with capacities from 500 to 15,000 cfm—at 3 to 20 psig. on air service. For handling gases, special construction, materials and seals can be provided. Joy can also furnish reciprocating, multi-stage centrifugal and axial flow compressors to handle any air or gas compression requirement of the chemical processing industry. For full information on the Joy Model G Centrifugals, write for Bulletin 2468-11.

**AIR MOVING EQUIPMENT FOR ALL INDUSTRY**



# JOY

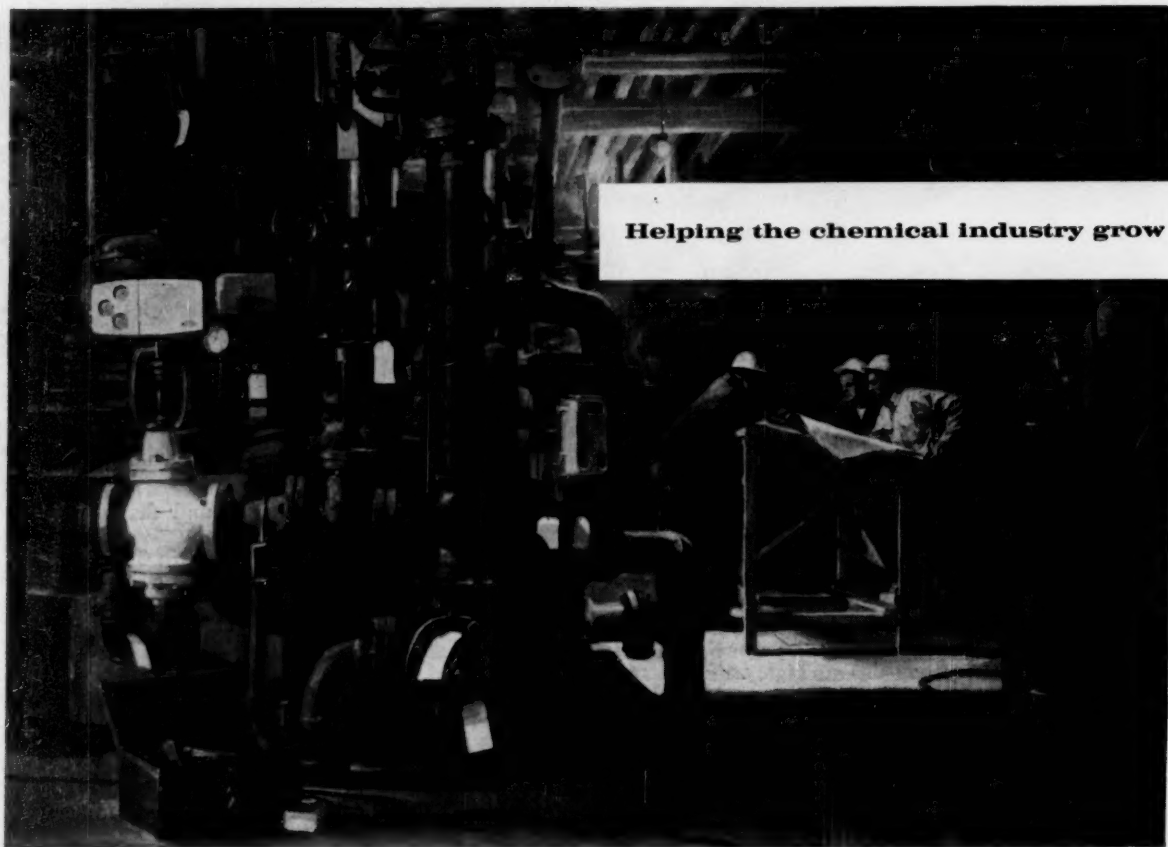
Joy Manufacturing Company  
Oliver Building, Pittsburgh 22, Pa.

In Canada: Joy Manufacturing Company  
(Canada) Limited, Galt, Ontario

# Chemical pipe maze

Surrounded by an intricate complex of pipes and carefully tagged valves, fitters consult their blueprints for the next step toward completion of this modern chemical processing plant. For many years United Engineers has served America's fast-growing chemical industry on projects of widest scope and variety. Each project has demonstrated our ability to operate efficiently within a budget and on schedule. Our growing list of new clients, plus the many new assignments from those previously served, is proof of the confidence placed in us. For your next chemical processing project—as well as power plant, steel mill, industrial or utility installation—we invite you to profit from our background of over 75 years' experience as designers, construction engineers, and engineering consultants.

Painting by Robert Lavin



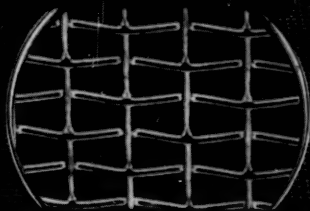
Helping the chemical industry grow

## UNITED ENGINEERS

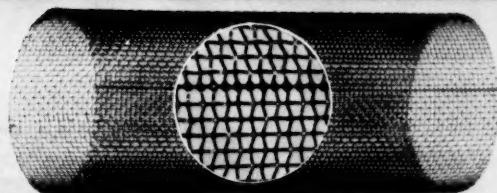
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# Need Wire Cloth Specials? Call *Cambridge*

**BRAZED**

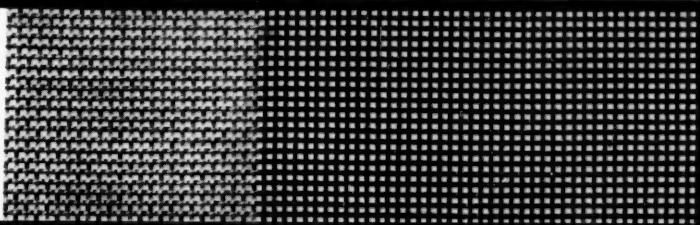


**SEAMLESS**



**TEFLON\* COATED**

Right Side Coated



\*Reg. T.M. of DuPont Company

These are just 3 of the many wire cloth specialties Cambridge can produce for you—no matter how large or small a quantity you need. Or, if you have an extra-special problem, there's an expert on hand to discuss your special needs . . . your Cambridge Field Engineer. He can show you how to get the results you want—in the quickest possible time at the lowest possible cost.



Your Cambridge Field Engineer is listed in the Yellow Pages under "Wire Cloth." Call on him at any time. Or, write for illustrated, 120-page catalog.

## If Your Problem Involves Standard Metals or Alloys . . .

we make wire cloth from any metal or alloy that can be drawn into wire . . . in nine basic weaves, and with accurate mesh count and mesh size. Ask about immediate deliveries from our enormous stocks of the most frequently used types of cloth in a wide range of mesh sizes.

Refer to our technical data sheets in **CHEMICAL ENGINEERING CATALOG**, Page 185

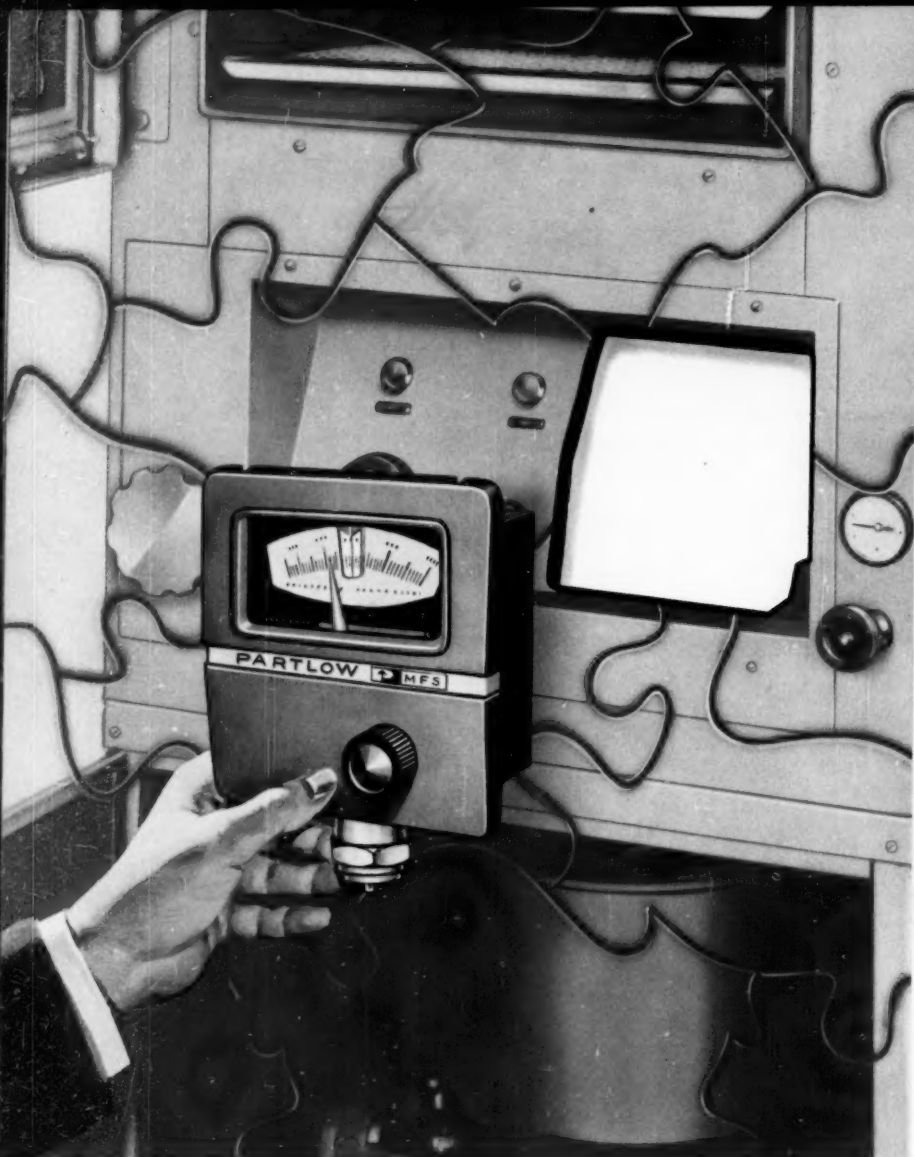


## THE CAMBRIDGE WIRE CLOTH CO.

DEPARTMENT G • CAMBRIDGE 2, MARYLAND

Manufacturers of Metal-Mesh Conveyor Belts, Flat Wire Conveyor Belts, Wire Cloth, Wire Cloth Fabrications and Gripper® Metal-Mesh Slings.





Partlow makes 25 different indicating control models, including the handsome, high-visibility MFS shown here.



Partlow non-indicating controls give maximum dependability at minimum cost.

## A Perfect Fit for Any Temperature Control Application!

Partlow temperature controls today function in an almost infinite range of industrial processes . . . Economically. Accurately. *Precisely!*

They can perform just as efficiently for *you*.

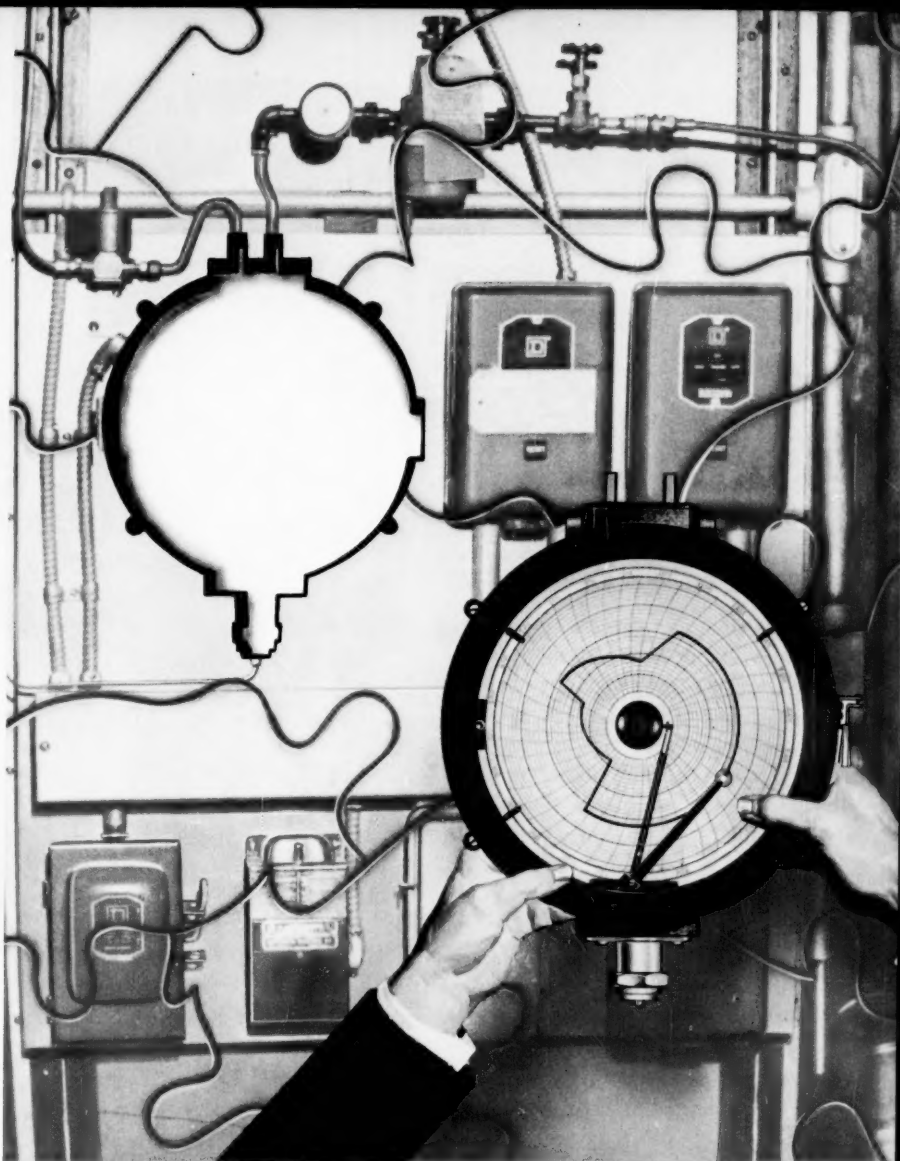
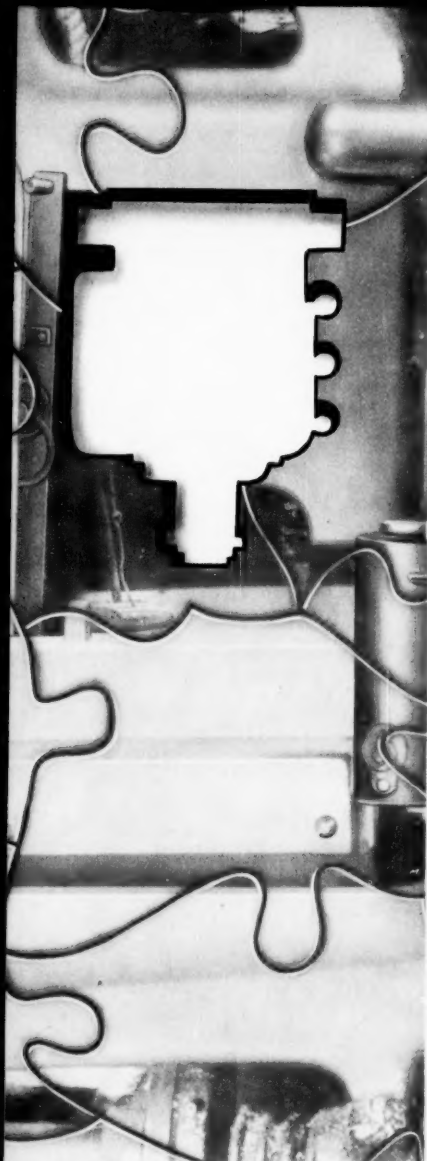
Partlow controls are actuated by the direct, positive power of mercury, require no mechanical or electronic amplification. Regardless of type, any Partlow you install will stand up to even extreme conditions of shock and vibration . . . without loss of accuracy or sensitivity.

And Partlow makes service headaches a thing of the past! All it takes to replace the Partlow thermal element is a wrench or screwdriver. No 'down time' necessary! The whole job can be done, right at the work site, in a matter of minutes.

If you need accurate, dependable temperature control anywhere within the  $-70^{\circ}$  to  $1100^{\circ}\text{F}$ . range, you'll find a Partlow model to fit your requirements *exactly*.

Get full details without obligation. Fill out and mail the coupon now.





Versatile Partlow recording instruments keep rigid control of process temperatures, and prove it in writing.

Partlow makes the following types of controls and allied equipment for temperatures ranging from  $-70^{\circ}$  F. to  $1100^{\circ}$  F.:

- Electric
- Mechanical
- Pneumatic
- Indicating
- Non-Indicating
- Recording
- Explosion-Proof
- Weather-Resistant
- Limit
- Program
- Multi-Switch
- Double Pen Recording
- Process Timers
- Safety Equipment
- Thermometers
- Control Accessories

41 Partlow Sales and Service Offices in Principal Cities of the United States, and the World.

World Export: Ad Auriema Inc.,  
85 Broad Street,  
New York 4, N.Y., U.S.A.



## PARTLOW

### TEMPERATURE CONTROLS

#### THE PARTLOW CORPORATION

New Hartford, N.Y., Dept. B

Please send condensed Catalog of Partlow temperature controls and allied equipment for industrial heating and refrigeration.

Name and Title.....

Company.....

Address.....

City and State.....

# HOW *HERCULES* HELPS...

## SOLVE CONCRETE PROBLEMS

Construction men are quickly acknowledging the fact that concrete treating compounds based on Parlon® chlorinated rubber provide these advantages. They reduce construction costs because they allow the cured concrete to be painted, bonded, or directly tiled over without the necessity of removing the treating compound. These products also eliminate the use of burlap, plastic sheeting, and other coverings that were previously needed to prevent evaporation and allow the fresh concrete to cure properly. Whether the concrete construction is bridges, building construction, landing strips, or highways, you will have better performance where compounds based on Parlon chlorinated rubber are used.



**YOU CLEAN AND DISINFECT** more quickly and easily. Pine oil cleaners are known to be universal in their ability to clean and deodorize. When used in sufficient quantity, pine oil becomes an efficient disinfectant as well as a cleaning agent. Today, many manufacturers of these cleaners rely on this wonder working ingredient, Yarmor® pine oil, to make their products more reliable and widely acceptable not only in the home, but also in industry.

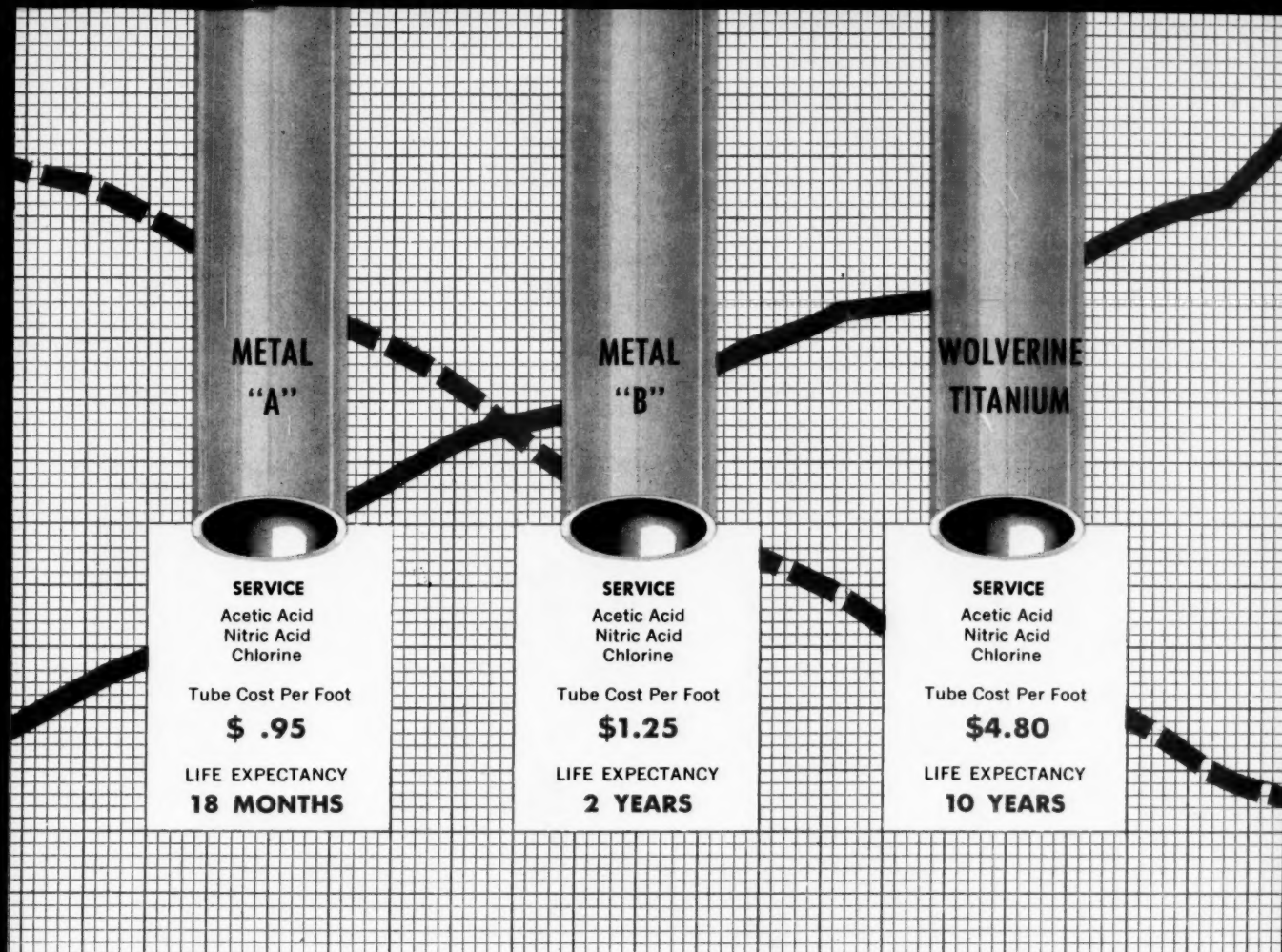


G61-1

**HERCULES POWDER COMPANY**  
INCORPORATED  
Hercules Tower, 910 Market Street, Wilmington 99, Delaware

**CHEMICAL MATERIALS FOR INDUSTRY**

**HERCULES**



## Consider the long range payout of Titanium vs standard metals and alloys

Wolverine Tube is certain that you know all about equipment payout—and how it can be affected by costly maintenance and downtime, particularly in corrosive services.

But perhaps you haven't considered how important it is to look beyond first costs—to get the big picture of what Wolverine titanium heat exchanger tubing can do for your company's long range requirements.

In addition to the services illustrated in the charts above, consider the increasing use of sea water for cooling purposes. Most ferrous and nonferrous alloys in this service have a tendency toward stress corrosion cracking and pitting. On the other hand, titanium is completely immune to these faults when handling salt water.

Thus, as in the services charted above, titanium heat exchanger tube, though having a greater first cost, is more economical in the long run because it gives greatly increased and uninterrupted service life.

It's a big subject and one that requires more space than we have available here. Why not talk it over with your Wolverine sales representative? He can point out in detail the many ways in which titanium heat exchanger tube can save you time and money.

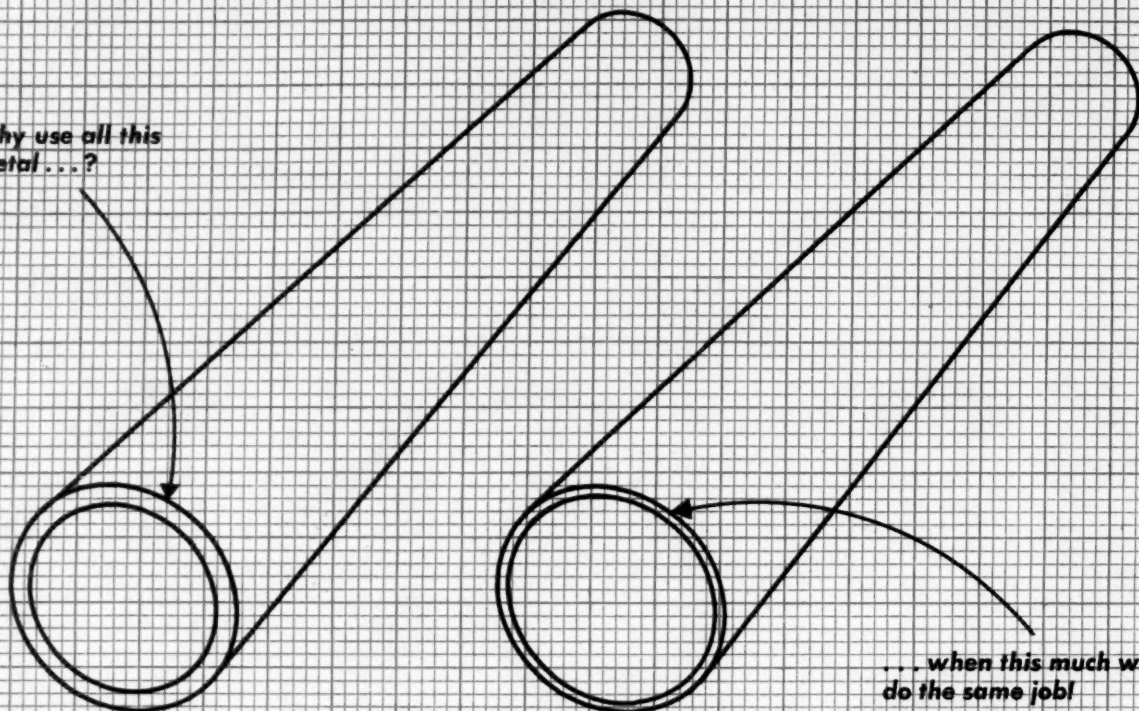


**WOLVERINE TUBE**  
DIVISION OF

**Calumet & Hecla, Inc.**

DEPT. J, 17232 SOUTHFIELD RD., ALLEN PARK, MICH.  
Manufacturers of Quality Controlled Tubing

Why use all this  
metal...?



... when this much will  
do the same job!

## Wolverine Titanium Heat Exchanger Tube helps eliminate waste metal

When analyzing the effectiveness of titanium heat exchanger tubing, in comparison with standard metals and alloys, it must be remembered that because of titanium's great resistance to corrosion, a lighter walled tube can be used in many applications.

For example, Wolverine titanium heat exchanger tube with .049" wall thickness and less can successfully handle products such as acetic acid, nitric acid and chlorine—among others. When compared to the much heavier walled tubing in certain other metals normally used in such services, it is apparent that substantial savings can be made in both unit weight and structural support.

This important factor also helps reduce the end cost of titanium heat exchanger tube and makes this metal

even more attractive when compared to other metals having lower initial cost, but requiring heavier wall thickness because of their accelerated corrosion rate.

For complete information about Wolverine titanium heat exchanger tube, just talk to your Wolverine sales representative. He can give you the entire story about Wolverine's work in titanium and other special metals.



**WOLVERINE TUBE**  
DIVISION OF

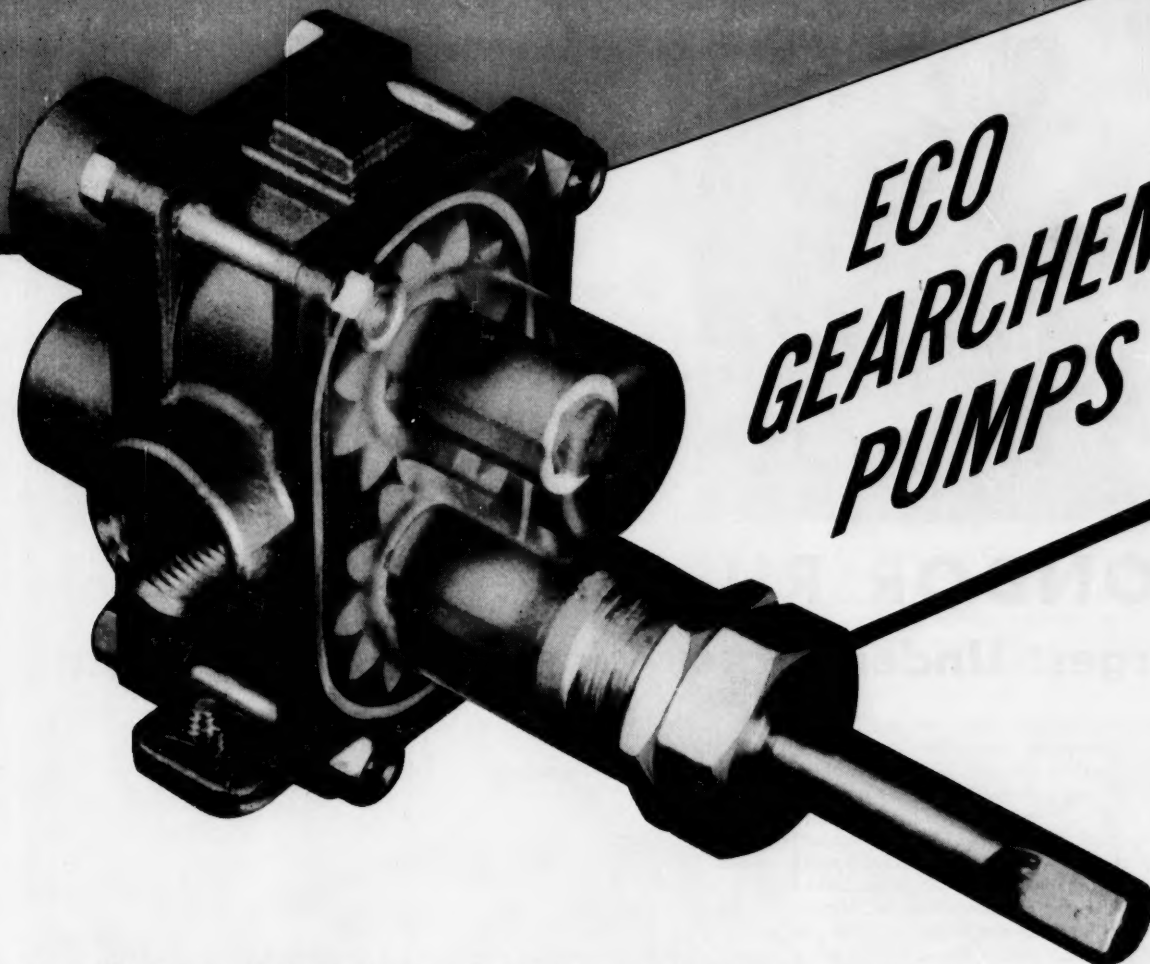
**Calumet & Hecla, Inc.**

DEPT. J, 17232 SOUTHFIELD RD., ALLEN PARK, MICH.  
Manufacturers of Quality-Controlled Tubing



# LOOK INTO...

## ECO GEARCHEM PUMPS



For wide application, reliability and economy in Pumping "difficult" media—look into Eco GEARCHEM Pumps.

Handle acids in most concentrations (including hot HCl and H<sub>2</sub>SO<sub>4</sub>); alkalis; solvents; viscous resins (to 30,000 SSU); mercury, etc.

Flow rates to 10 gpm with pressures to 100 psi. Ideally suited for closed loop systems operating under either high vacuum or pressure and wide temperature ranges. Self-priming. Suction pressures to 5 mm abs. Self lubricated by the medium pumped.

Standard stock pumps, immediately available, with

housing of Zirconium, Titanium, Nickel, Hastelloy\*B and C, Monel, Carpenter 20 and Type 316 Stainless Steels.

Equipped with interchangeable gears of Teflon†, Penton‡, phenolic and polyamide resins, synthetic hard rubber and Hastelloy B or C. Packings of Teflon or Teflon in combination with other suitable plastics, in conventional or lantern ring stuffing box.

Eco GEARCHEM Pumps are mass produced on the latest automatic "program" machine tools to pass on to you optimum quality and service at lowest cost.

**Write for Literature on any or all of the Eco stock pumps shown below for handling corrosive or hazardous processing fluids.**

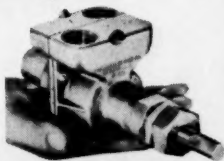
\*Union Carbide Trademark. †du Pont Trademark. ‡Hercules Powder Co.

# ECO

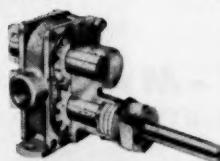
*the big-name in small pumps for the process industries*



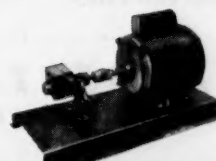
**CENTRI-CHEM LINE**



**ALL-CHEM LINE**



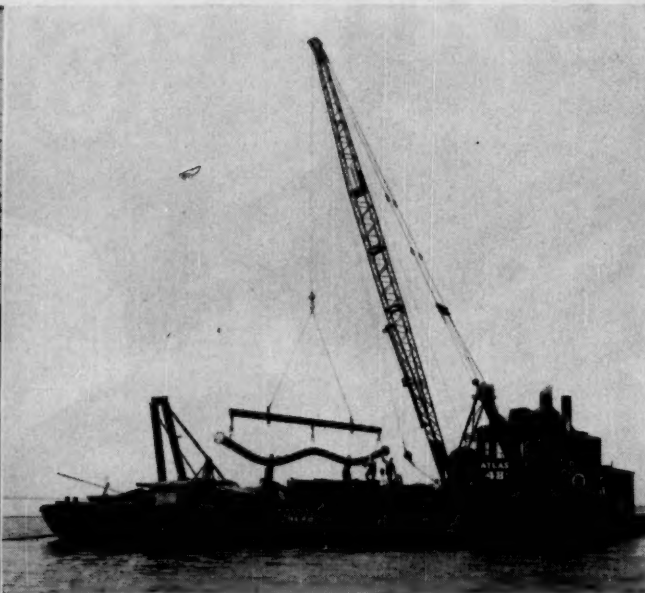
**GEARCHEM LINE**



**MINILAB LINE**

**ECO ENGINEERING COMPANY • 12 New York Avenue • NEWARK 1, N.J.**



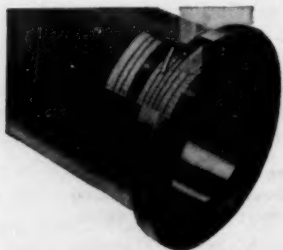


## CONDOR RUBBER PIPE used for Largest Under-Water Waste Disposal System

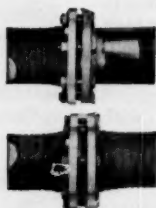
A large chemical plant has installed 1864 feet of 12" diameter Condor Flexible Rubber Pipe in the lower Delaware River to discharge process wastes from shore to the river channel. Condor Rubber Pipe provided flexibility to permit bolting 50' lengths together on the deck of the dredge and laying them into a trench in the river bottom. This was easier than bolting or welding a metal pipe-line under water . . . and the rubber pipe will last longer than metal against salt water corrosion outside; nitric and sulfuric acid wastes inside.

Condor Flexible Rubber Pipe outlasts steel 3 to 10 times. It is made in types to withstand pressures up to 250 psi. Installation is easy, economical—and there's no danger of leaky joints at pipe bends. New Hydro-Lok built-on flanges offer full sealing surface *plus* advantage of sure alignment and easy rotation of pipe to equalize wear—*without* removing flange bolts.

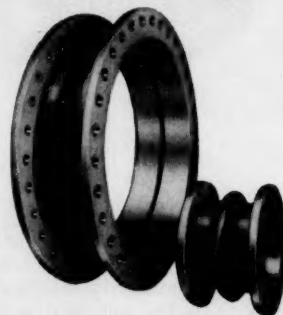
Let an R/M representative give you details on Condor Flexible Rubber Pipe . . . or write today for Bulletin 7152.



- Steel Pressure Ring molded into Hydro-Lok Flange
- Thick, corrosive resistant tube
- Multiple plies of heavy duck
- Reinforcing spiral of steel spring wire
- Tough durable cover



Hydro-Lok Flanges may be used with equal ease to couple rubber pipe to iron pipe with standard flanges (top) or existing sections of rubber pipe using other flanges.



### R/M RUBBER EXPANSION JOINTS

- Overcome Pipe Expansion Stress
- Avoid Piping Misalignment
- Resist Abrasion and Corrosion
- Offer Maximum Resistance to Shock
- Require No Gaskets

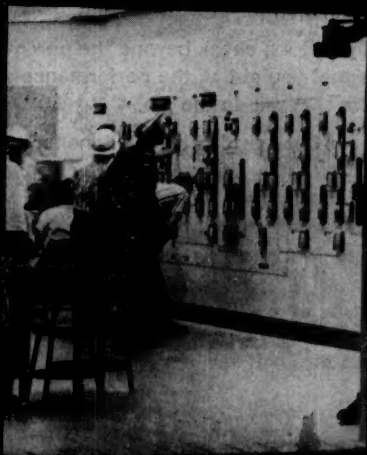
**RAYBESTOS-MANHATTAN, INC.**  
MANHATTAN RUBBER DIVISION, PASSAIC, NEW JERSEY



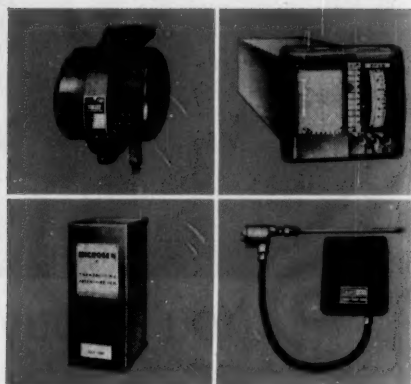
RW 1008  
ENGINEERED  
RUBBER  
PRODUCTS  
... MORE USE  
PER DOLLAR

12:30 A.M.

*Everything's  
under Control!*



All's right at half after midnight. The new shift settles in to monitor the processing steps. Meanwhile, out among the towers, Robertshaw-Microsen® Electronic Systems are providing maximum automation for data acquisition, transmission, recording and control of process variables. It's a typical job for Robertshaw — keeping everything under control. For greater system flexibility, lower initial investment and minimum operating costs — specify Robertshaw-Microsen for precision control of pressure, temperature, differential pressure, oxygen concentration, liquid level, gas analysis, pH, flow. Over 50 sales-service offices — write for address of the one nearest you — and for Technical Bulletin 10, entitled "Process Instrumentation."



*Shown above: (Top, l. to r.) Microsen Transmitter, Microsen Recording Controller. (Bottom) Microsen Transmitting Potentiometer, Level-Tek Level Detection and Control System.*



*Aeronautical and Instrument Division  
Robertshaw-Fulton Controls Company,  
Santa Ana Freeway at Euclid Avenue  
Anaheim, California*

# MOTORS BY THE POUND?



## You're buying motors by the pound when price is the only consideration

Sure, you can get a motor for the lowest price, a motor of the same type and with the same rating and operating characteristics of the highest priced motor. But, while initial price is an important factor, the actual cost is the ultimate cost of a motor. And, ultimate cost includes the repair bills, lost production, lost man hours and lost customers that an inferior, built-down-to-a-price motor could cost you.

Wagner® protected polyphase motors do cut expensive downtime. Their cast iron frames can't be affected by corrosive acids, salts, or alkalis. They are designed for cool running . . . stator temperatures stay low to in-

crease motor life. Wagner polyphase motors are designed to permit relubrication that adds years to motor life under severe operating conditions. Wagner motors have earned a reputation for proven dependability.

Next time you buy motors, check beyond the purchase price. Make sure that you get all the performance you need—with motors that will do the job.

Wagner motors have been getting the job done for more than 65 years. Your Wagner Sales Engineer will be glad to show you why. Call him for an analysis of your next motor application, be it for plant or product.

*Branches and Distributors in all Principal Cities*

**Wagner Electric Corporation**

6407 PLYMOUTH AVENUE, ST. LOUIS 33, MISSOURI

WM61-3



**HANDLES 32% HCl AT AMBIENT TEMPERATURES**—Workman is painting a section of Fibercast Pipe bearing 32% HCl at a Shell chemical plant. Note that Fibercast has sufficient strength for installation on span racks with the spacing normally used for metal pipe.

## New pipes handle temperatures and pressures where no other pipes will do



### WHAT is Fibercast?

It is a centrifugally cast, thermoset, epoxy resin reinforced pipe that handles temperature and pressure problems where no other non-metallic pipe will do. Its body of woven glass fibers resists high tension forces, is imbedded and bonded by heat in epoxy resin. Result: strong, long-lasting pipe that resists high pressure and temperatures in corrosive environments.

### WHERE should Fibercast be used?

The petroleum industry . . . chemical . . . petro-chemical . . . nuclear energy . . . textile . . . paper . . . and food-processing industries . . . countless operations handling acids, alkalis, salt water and other corrosive liquids under pressure.

Wherever ease of handling, lightweight, dielectric properties and structural stability are desirable in a material that is at the same time outstandingly resistant to heat, pressure and corrosion.

### WHY use Fibercast?

Because its advantages of superior resistance to heat, pressure and corrosion give Fibercast long service life that would alone justify choosing it over other materials.

Because even more expensive metal pipe or pipe with thermoplastic interior coatings cannot match Fibercast's proven durability.

Because case histories and accurate testing have proved over and over again that Fibercast performs better, lasts longer, costs less.

Because out of 338 common corrosive solutions, Fibercast competently handles 320.

And, naturally, because Fibercast's unique and lasting qualities under

such conditions mean that it drastically reduces maintenance and replacement costs, too.

#### COMPARATIVE LIFE DATA\*

FIBERCAST, GRADE J	1.00
ALUMINUM	.26
BRASS (REA)	.74
RUBBER HOSE	.210
STEEL (Stainless 304-40)	.311
ASBESTOS (Cement-C-100)	.237

\*Basing Fibercast as unit life of 1 and others as comparative percentages thereof.

Remember, also, that the three major systems of joining all pipe are used with equal success on Fibercast (standard flanged, cemented, and threaded and coupled), and with a complete selection of Fibercast Fittings. It's the world's largest line of corrosion-resistant epoxy pipe fittings!

Get the full story on Fibercast's cost-saving advantages to industry. Learn how it can help you solve your pipe and tube problems. Don't wait, mail coupon today!



Fibercast Tubing (right) used to suspend a 1,200 lb. pump for 3 years in a salt water supply well. There was no loss in strength. The damaged plastic-coated steel nipple (left) was used in the same installation, failed after 3 months service.

**FIBERCAST** COMPANY  
A DIVISION OF **Y**oungstown SHEET AND TUBE COMPANY

**FIBERCAST COMPANY CE-261**  
Box 727, Sand Springs, Okla.

Please send me further information about Fibercast Tube and Pipe.

Name \_\_\_\_\_

Title \_\_\_\_\_

Firm \_\_\_\_\_

Type of Business \_\_\_\_\_

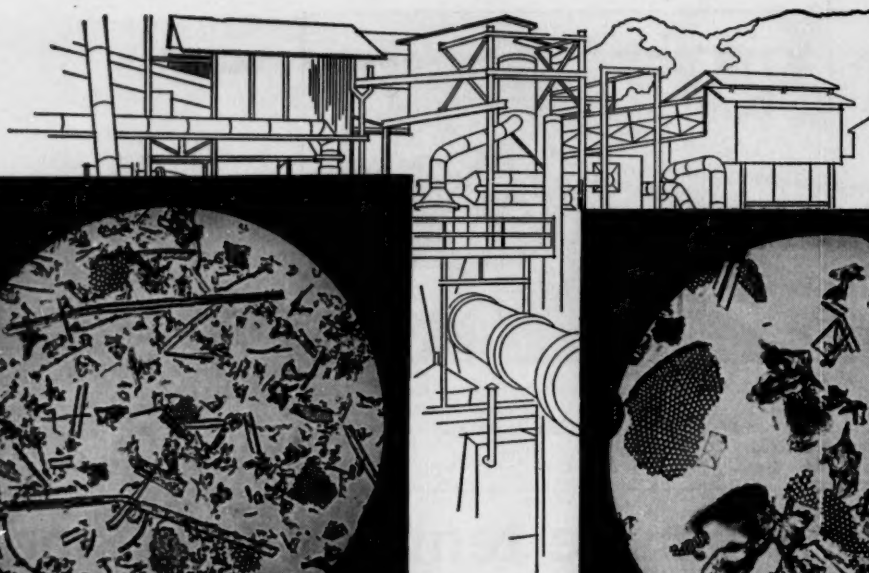
Address \_\_\_\_\_

City \_\_\_\_\_

Zone \_\_\_\_\_

State \_\_\_\_\_





Milling and calcining equipment used for all Celite grades.



For high-clarity filtration of most liquids—use this specially milled diatomite, Hyflo Super Cel.



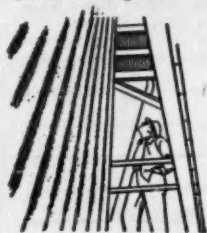
For filtration of larger suspended particles—Celite 545 combines maximum clarity plus faster flow rates.

*In diatomites, Johns-Manville precision processing works for you*

## Constant uniformity in every grade of Celite assures consistent results, less down-time



For mineral filler use—Super Floss grade is made up of carefully sized fines air-floated off in the bag house.



Typical J-M bag house equipment.

AS THE MICROSCOPE SHOWS, each grade of Celite® diatomite has its own distinctive particle size distribution. Yet no matter where or when purchased, each remains uniform from bag to bag—your assurance of top production results with minimum down-time.

Three examples of flux-calcined Celites are shown here. Hyflo® Super Cel is widely used for filtration in many industries. It has just the right combination of coarse and fine particles to assure optimum clarity and flow rates. Celite 545, with a higher percentage of coarse particles, is used to achieve maximum clarity and faster flow rates with liquids that have larger suspended particles.

Super Floss, one of several bag house grades, has fine particle size distribution. A white powder, it is processed within very narrow tolerances (less than 1% retained on 325 mesh). It is a popular filler in fine products such as silver polishes.

Johns-Manville can precision-produce so many different grades of Celite because it mines the material from the world's largest and purest commercially available deposit. For assistance with specific filtration or mineral filler problems, talk to a nearby Celite engineer. Or write direct to Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ontario.

\*Celite is Johns-Manville's registered trade mark for its diatomaceous silica products.

# JOHNS-MANVILLE



## HOW TO DESIGN A TRADEMARK

Why, it's easy as A-B-C. Just start with a simple shape, one that's readily identified and easily remembered. (The Jenkins Diamond is a good example.) Then just fill in the blank spaces. That's all there is to it, and almost anyone can do it!

## HOW TO MAKE IT MEANINGFUL

Ah, that isn't so easy nor so simple.

A trademark is like a man's signature: it can mean much or it can mean little.

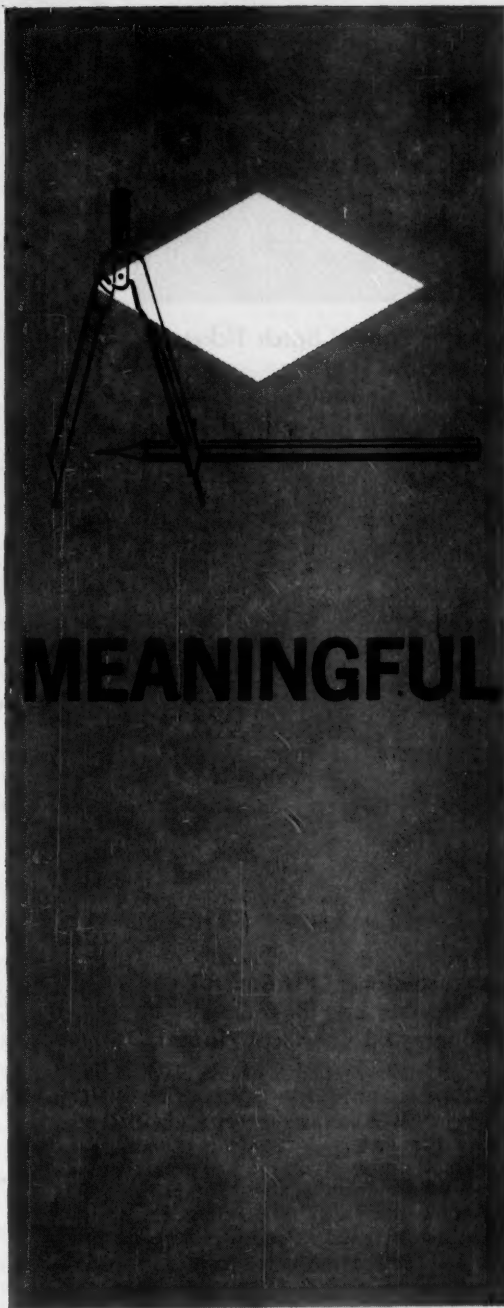
*Time and performance* make the difference.

Take the Jenkins Bros. trademark. There's nothing tricky about the design, certainly nothing fancy about the words.

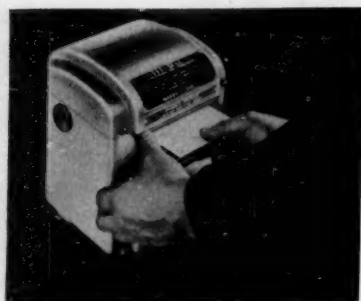
**Yet buyers and specifiers of valves everywhere know and respect this simple device, this mark.**

Why? Because in all the years since 1864 there has been no compromise in the *quality* of Jenkins Valves. We know it; you know it.

And that is the only way we know to make a trademark *meaningful*. That will always be the Jenkins way of making valves.



JENKINS BROS., 100 PARK AVENUE, NEW YORK 17



### Meter Printed Batch Tickets ... New Tool for Quality Control

A meter that automatically prints a ticket after each delivery now offers permanent proof of liquids fed to batches. Called the Print-O-Meter, it prints exact quantities, with serial numbers and code letters to identify the batch and/or station.

Operation is fool-proof. The ticket is inserted and locked in place in the meter before delivery. The ticket cannot be removed before being printed out.

As a dispute-free record, it's a strong incentive for careful handling of liquids, and automatically improves quality control. The printed tickets aid inventory, too, and can even be used to indicate daily or weekly production rates.

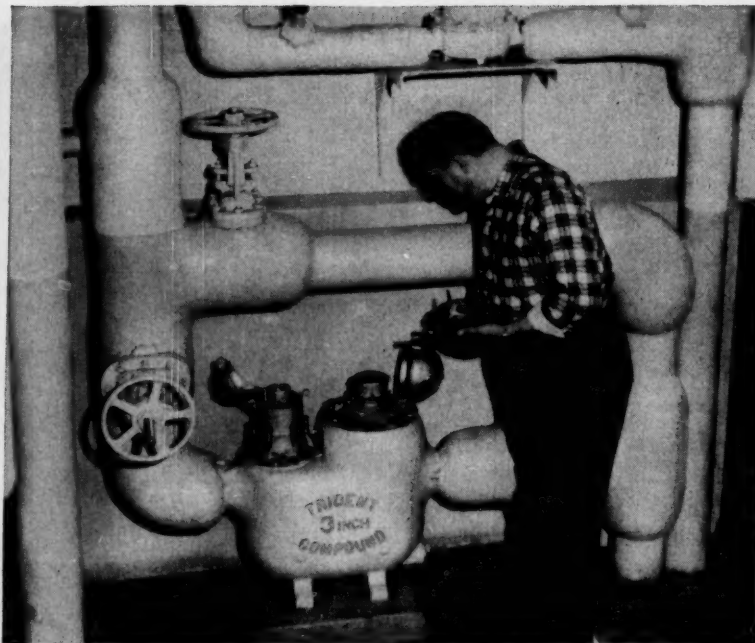
The Print-O-Meter is available with Neptune Meters in sizes from 1 to 4 in.; capacities 5 to 500 gpm.

### "Process and Cost Control 2 Big Reasons for Meters" Report 485 Chemical Plants

In an unbiased survey of 485 chemical plants who use positive displacement meters, more than half use the meters for batching and blending process control, and nearly the same number reported using the meters specifically for cost accounting and inventory figures.

In all, 803 applications for meters were cited, most of them using the same meters for both batching and accounting. Many applications involved the use of several meters. Many other uses in process control were given.

Water... cold, warm and hot... was the leading liquid being metered, but it accounted for only about 40% of the applications. Other liquids reported in this survey include fuel and lube oils, gasoline and other light petroleum fractions, organic solvents, vegetable and animal oils, sugar solutions, certain caustics and acids, alcohols, resins, gums, brines, etc.



## How Ansco's 101 NEPTUNES save millions of gallons daily

Snapshots at popular prices depend to an amazing extent on water. Ansco Manufacturing Company, Binghamton, N. Y., needs many million gallons every day...water for vital heating, cooling, air conditioning...expensively treated water for chemical processes.

Cutting water costs to the bone, Ansco has found ways to re-circulate and re-use water an average of  $2\frac{1}{2}$  to 3 times before it is reluctantly released.

Key to the program is metering. Over 100 Neptune water meters keep guard 24 hours a day. Each department is charged for the water it uses. The meters help compute heating and cooling values, blending proportions, chemical treatment required, etc., for most economical re-use.

If water is important to you, make sure you too are saving all you can with meters. We'll gladly make a survey. No obligation, of course.

### Life History of a Gallon of Water at Ansco

1. Well water at 53° used first for air conditioning
2. Chlorinated, used for spray washing
3. Used in chemical dehumidifier
4. Passes through heat exchanger
5. Passes through ammonia condenser
6. Goes to fire protection reservoir
7. Finally used to cool roof



### GET THE FACTS

Ask for helpful  
Meter Data  
Bulletin 566 M  
See Neptune Data  
Pages in Chemical  
Engineering Catalog.

## NEPTUNE METER COMPANY

LIQUID METER DIVISION

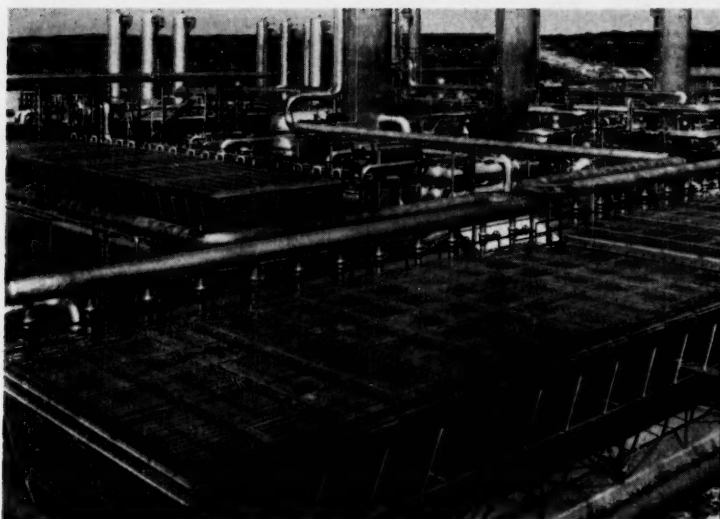
47-25 34th St., Long Island City 1, N. Y.

# neptune

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IT'S CHEAPER TO

# KILL HEAT WITH AIR



## COMPARE TRANSAIRE

... no matter what your water situation. Transaire air-cooled heat exchangers already have found wide acceptance in areas where water cooling is impractical or impossible. And now, finding that Transaire is less expensive to operate, even where water is plentiful, other areas are turning to this economical unit.

Simple in basic design, Transaire units are being used in many varied operations where low maintenance and low operating costs are important over extended periods of time. The high heat transfer efficiency is attained by use of the Yuba fintube. Its exclusive design employs tapered spiral fins mechanically bonded so that the entire base tube is covered and protected against the galvanic action that destroys efficiency in many other types of fintube. Both fins and base tubing can be provided in almost any material, size or gauge desired. Fin spacing and height can be varied to requirements. It's cheaper to kill heat with air—next time compare Transaire, a product of Yuba, pioneers in air-cooled heat exchangers.

*Yuba also manufactures a complete line of shell and tube heat exchangers, and will recommend either type, whichever is required or best suited for the job.*



*specialists in heat transfer equipment*

**YUBA HEAT TRANSFER DIVISION**

**YUBA CONSOLIDATED INDUSTRIES, INC.**

Sales Offices in Chicago • Houston • Los Angeles • New York • Pittsburgh • San Francisco



# YOU CAN COUNT ON FABRICATION TO YOUR SPECIFICATION

WITH PETROCHEMICAL PROCESSING EQUIPMENT

AT NEWPORT NEWS



This reactor cap is made of molybdenum plate. Top courses are  $1\frac{13}{16}$ " thick and the lower courses are  $1\frac{9}{16}$ " thick.

Newport News is famous for the painstaking care that goes into every step of the fabrication of heavy process equipment for the petrochemical industry.

A separate, fully equipped shop specializes in the production of all types of pressure vessels and process equipment. Rolls, ovens and other machinery can handle plates up to 5 inches thick. Qualified staffs of engineers and technicians backed up by hundreds of skilled workmen use the most advanced techniques to produce vessels to all specifications. The 225-acre Newport News plant also contains a

foundry capable of producing individual castings up to 100,000 pounds, forge facilities that can process units weighing as much as 48,000 pounds and machine shops equipped to mill pieces up to 42 feet in diameter.

Use the men, the methods and the machines of Newport News for your next project. Learn how Newport News can produce your needs . . . on time and to specification. Write today!

**Newport News**

SHIPBUILDING AND DRY DOCK CO.  
NEWPORT NEWS, VIRGINIA



$H_2O$   $Cl_2$   $C_2H_5OC$   $BrF_3$   $H_2SO_4$   
 $N_2CN$   $H_3PO_4$   $ClF_3$   $HCl$   $HF$   
 $Al_2(SO_4)_3$   $Br_2$   
 $HNO_3$   
 $CH_2:CHCl$   
 $Hg$

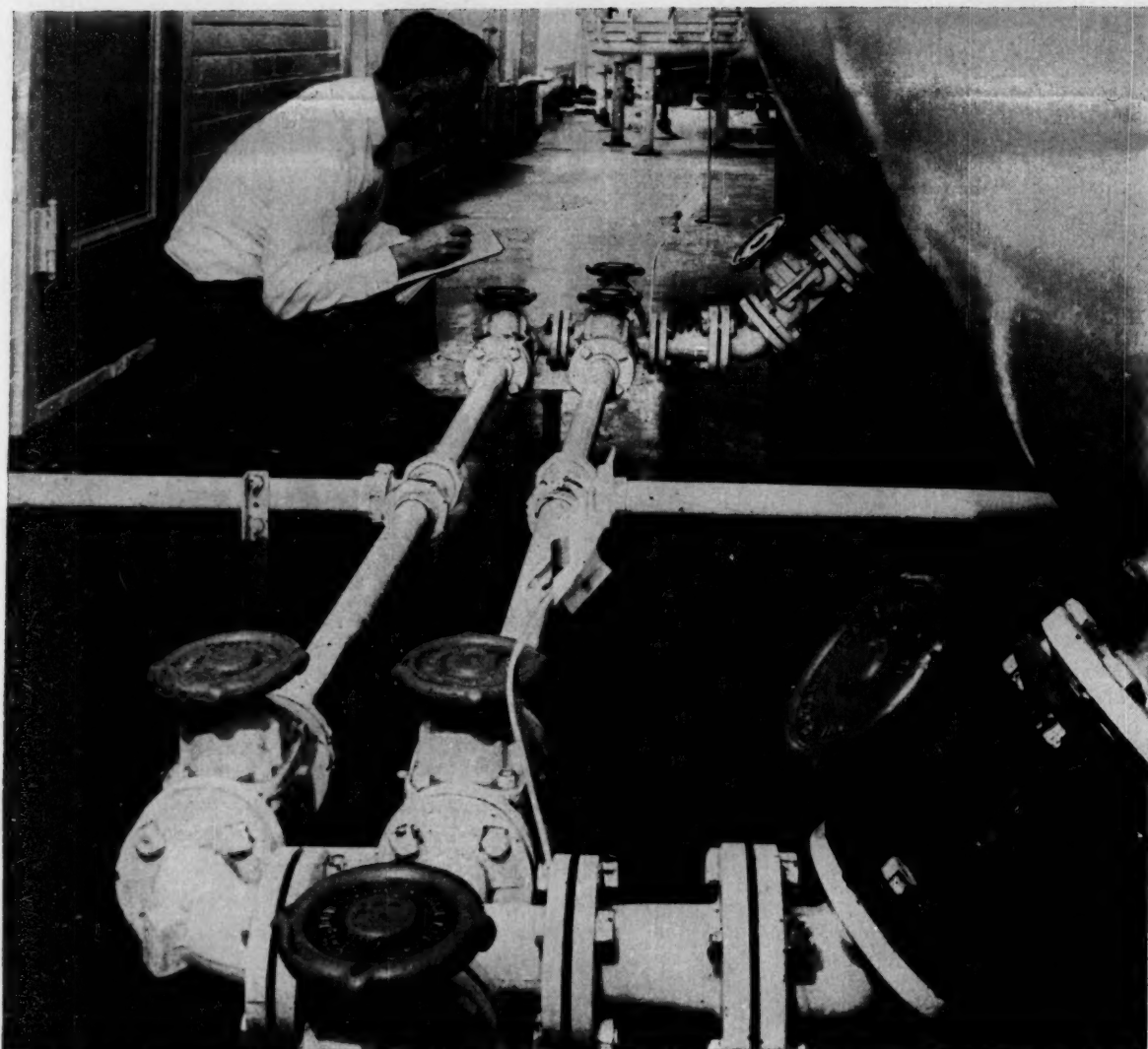
## You name it... PULSAFEEDER meters it!

Corrosive acids or just plain water . . . abrasive slurries or radioactive fluids . . . Lapp Pulsafeeder pumps them all safely, meters them precisely, completely eliminates leakage and contamination. And you can fit the pump to your specific process from today's most complete line: metered flow rate from a few drops to 15.7 gallons per minute; pressures up to 7000 psig.; manual or instrument controls. Which for you?

**WRITE** for new Catalog 59. Lapp Insulator Co., Inc., Process Equipment Division, 1114 Poplar Street, LeRoy, N. Y.



**Lapp**



Parke, Davis & Company, Detroit, Michigan

## SARAN LINED PIPE—keeps $H_2O_2$ prescription-pure ...not one failure in three years!

The cargo: 3% pharmaceutical-grade hydrogen peroxide and deionized water . . . carried by a 300-foot pipeline, at floor level near heavy-traffic areas. Pipeline failure would cost \$500 per hour in production downtime. Saran Lined Pipe keeps this reactive material prescription-pure, without one case of breakage or failure from corrosion in three years' service!

At Parke, Davis & Company, Detroit, a 300-foot pipeline carries the peroxide solution from dilution tanks to the bottling line. "Three years ago, this line—which used to be ceramic pipe—needed rerouting. At half the cost of dismantling and reassembling the ceramic pipe, we built

the new line entirely of Saran Lined Pipe," says Department Manager D. W. Anderson. "The line went up rapidly because its longer pipe sections resulted in fewer joints and its strength eliminated the cost of extra supports."

No matter how corrosive or reactive your chemical material, consider Saran Lined Pipe. Saran Lined Pipe, fittings, valves and pumps are available for systems operating from vacuum to 300 psi, from below zero to 200° F. They can be cut, fitted and modified easily in the field without special equipment. For more information, write Saran Lined Pipe Company, 2415 Burdette Avenue, Ferndale, Michigan, Dept. 1563AK2-20.

THE DOW CHEMICAL COMPANY

**DOW**

Midland, Michigan



# Flow Sheet <sup>3</sup>

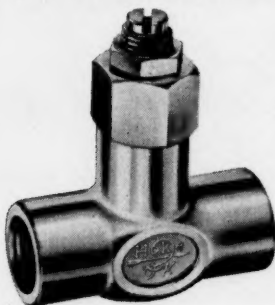
HOKE REPORTS ON FLUID CONTROL

## WE'VE TOSSED A NEW BALL INTO AN OLD GAME

### How Do You Gauge Protection?

Not that we're trying to put an end to our pressure gauge business, but the new Hoke gauge protector will save you quite a bit of money on gauge repairs and replacement. It will help soothe the savage temper of your maintenance man, which might be even more important.

The new 530 Series gauge protector prevents sudden pressure surges from damaging costly gauges. Mounted conveniently, and directly between the pressure source and the gauge, it can be set for any pressure protection point between 30 and 1000 psig and will handle inlet pressures to 3000 psig. Minimum burst pressure is 9000 psig, so you have a



good safety margin. Its widespread popularity among maintenance men is due to the fact that it does not have to be re-set when the pressure drops below the protection point.

Those more interested in technicalities should read this: The temperature range is  $-10^{\circ}$  to  $+200^{\circ}$  F, and the unit is usable in any clean gaseous service compatible with brass and Buna-N. It weighs only  $5\frac{1}{4}$  ounces, and measures  $1\frac{1}{8}$  inches from inlet to outlet. Both ends are  $\frac{1}{4}$  NPT female connections, so no adaptors or connectors are necessary for installation.

Specs are available, whatever your reason for wanting them—Write!

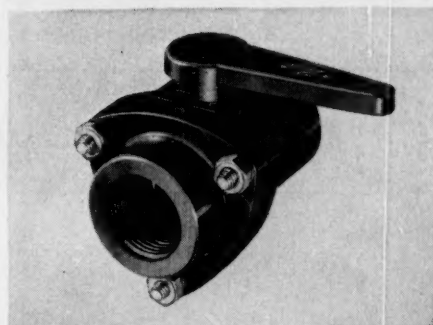
**SEE OUR CATALOG IN  
SWEETS PRODUCT DESIGN FILE**

The technique of molding polyvinyl chloride into ball valve parts is old hat. Even the unplasticized compounds of type I PVC have been kicked around for a while (with minor successes). But until now, no one has booted the ball for a goal.

Perseverance, determination, and the pursuit of economic reward have prompted us to offer a line of ball valves molded of the toughest grade of type I, unplasticized PVC. There are no foreign agents to contribute to a corrosive demise, even in most caustic services. It even meets the proposed new ASTM specification and has a tensile strength of 8500 psi. Those who have had PVC piping problems will profit from the new molding process that gives these Hokes dimensional stability and very high impact strength. Sensitive systems, human and otherwise, are safe from contamination—they're absolutely non-toxic. We've set  $140^{\circ}$  F. as the operating temperature limit, but occasional excursions to  $160^{\circ}$  F. won't do any harm.

All standard models are supplied with a concentric hole drilled thru the ball. They can be heat welded, or solvent bonded right in the line. Piping hook-up is even simplified by their coupling-like assembly. Your assistant can fit each half of the valve to a pipe end, then reassemble the valve without having to turn the pipe. Pressures to 125 psi are duck soup for these valves.

A maintenance man's delight, they can be cleaned and have their seats changed without leaving the pipe. Their light weight makes them ideal for use on long, unsupported spans of pipe.



Size-wise, we're offering them in  $\frac{1}{4}$ ,  $\frac{3}{8}$ , 1,  $1\frac{1}{2}$ , 2, and 3 inch sizes, all NPT female connections.

You will command the eternal admiration of your colleagues when you install these valves. Be the first to show your rightful status by ordering a shiny new Hoke polyvinyl chloride ball valve. If pride of ownership hasn't motivated you at this point, the mere fact that you are behind the scientific times should move you to find out more.

It isn't necessary to tell us why you want the additional information. Just check the coupon below. We'll forward the facts in a plain, brown envelope.

### WHAT'S NEW FROM HOKE?

Lots of things have been happening at Hoke. To be sure you're up to date on these developments in fluid control see your nearest distributor. He'll have something new for you every other month this year.

**Hoke's Performance Guarantee — Every Valve Leak-Tested!**

#### HOKE, INCORPORATED

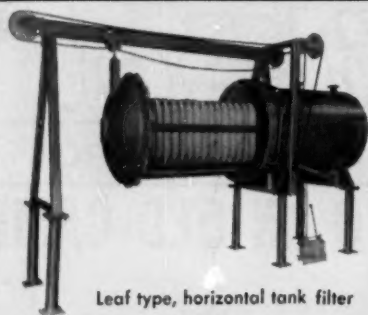
39 Piermont Road, Cresskill, N. J.

Send me complete information on the Hoke products checked below:

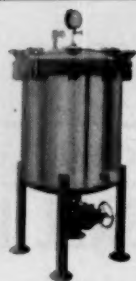
- ☐ PVC Ball Valves
- ☐ 530 Gauge Protectors
- ☐ Flow Sheet
- ☐ "What's New"
- ☐ Complete Catalog GC 960

NAME \_\_\_\_\_ TITLE \_\_\_\_\_  
COMPANY \_\_\_\_\_  
ADDRESS \_\_\_\_\_  
CITY \_\_\_\_\_ STATE \_\_\_\_\_





Leaf type, horizontal tank filter



Leaf type, vertical tank filter

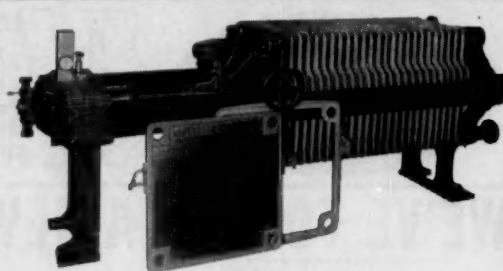
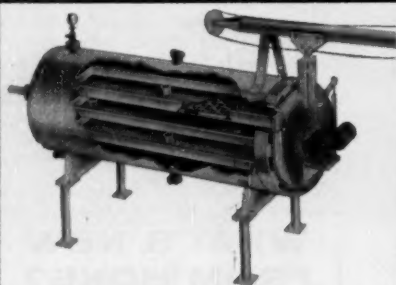


Plate and frame filter press

*It's true—we build many types of filters*



Rotary leaf type positive sluicing filter



Horizontal tray filter

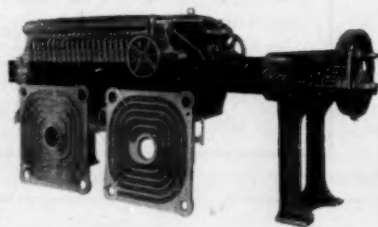
## *but primarily* **WE SELL FILTRATION**

The array of Shriver filters you see here represents various types we design and build for the process industries. But—more important—the kind of filter we recommend for your requirements is based on our technical investigations and laboratory tests to determine what is best suited for optimum operating efficiency and economy. Sometimes these analyses indicate the need for a filter not of our manufacture, and we tell you so frankly.

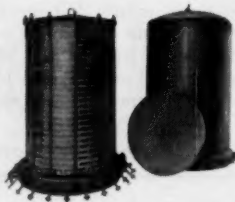
Such unbiased evaluations have helped build good will which our long experience has maintained at a high level.

That is why at Shriver's we try to "sell filtration," and the right filter for your process readily sells itself.

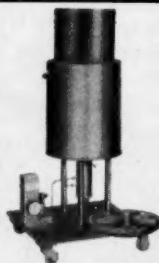
Let us work with you on your filtration improvement or expansion programs.



Continuous plate and frame slurry thickener and washer



Horizontal plate filter with hood type cover



Horizontal plate, tank type filter



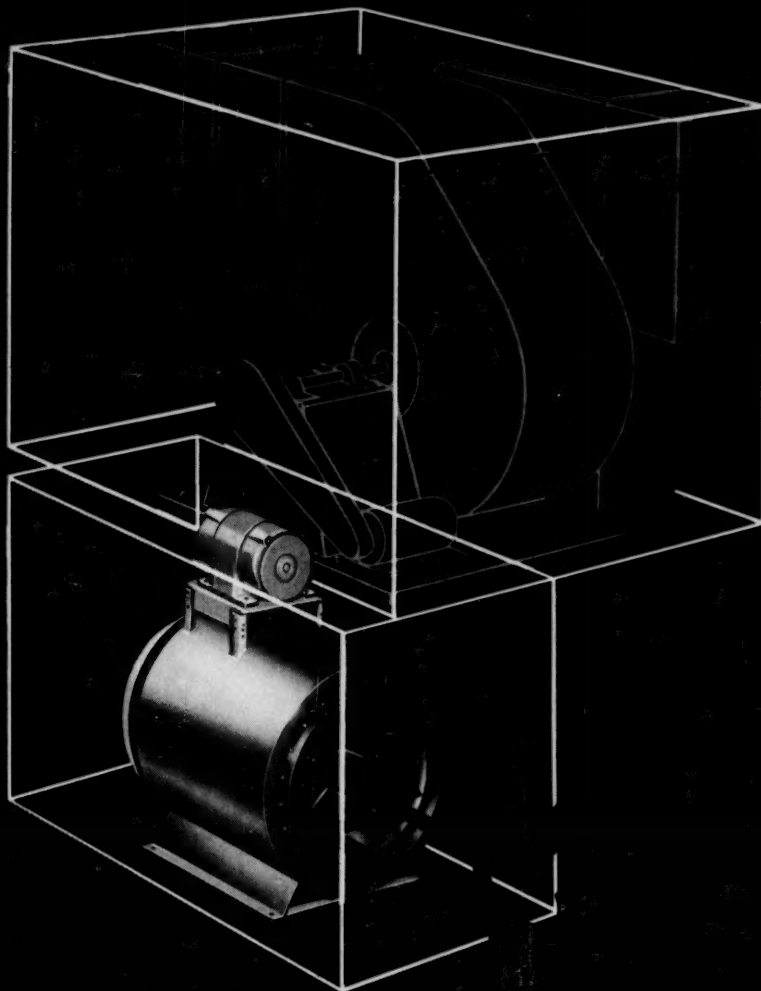
Diaphragm pump for abrasive, corrosive materials

**FILTERS AND COMPLETE  
FILTER STATIONS TO  
MEET YOUR EXACT  
PROCESSING NEEDS**

## **T. Shriver & Company, Inc.**

802 HAMILTON STREET • HARRISON, N. J.

*Sales offices in principal cities*



## Save space with the new in-line CENTRILINE fan!

Now from Westinghouse, a totally new type of fan...the in-line, Airfoil, centrifugal CENTRILINE®...gives you the Airfoil centrifugal fan performance of conventional fans in less than half the installed space.

The in-line air flow of CENTRILINE lets you save space by using in-line duct-work. Inlet and outlet dimensions are identical. You can hang CENTRILINE fans from ceilings, stack them, mount them on walls, as well as on floors and platforms.

Space saving? By using 49 of these compact fans, the Travelers Insur-

ance Companies of Hartford were able to design the air conditioning system for their huge home offices without stealing valuable office space...using only their existing equipment rooms.

CENTRILINE fans also insure quiet operation. Secret is a Westinghouse exclusive: the Airfoil-bladed centrifugal wheel. Save space, cut installation costs and reduce noise with CENTRILINE, for both commercial and industrial installations. Ask your consulting engineer. Mail coupon for detailed catalog.

J-80718

WESTINGHOUSE ELECTRIC CORPORATION  
Sturtevant Division, Dept. DB-15  
Hyde Park 36, Mass.

- ☐ Send me your CENTRILINE catalog.  
☐ Have an engineer call.

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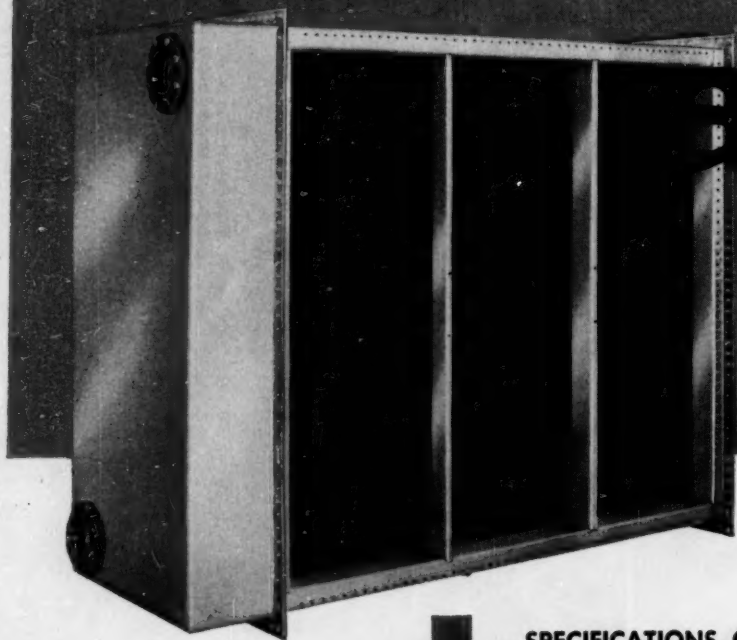
® — WESTINGHOUSE TRADEMARK

Westinghouse



# Marlo

## Liquid / Gas Heat Exchanger



any  
APPLICATION  
ALLOY,  
OR SIZE

Write or Phone  
for Additional  
Information for  
Your Application.

### SPECIFICATIONS ON THIS UNIT:

**MATERIAL:** 316 ELC Stainless Steel

Face Dimensions: 60" x 72"

Overall Dimensions: 98" x 68" x 30"

**TUBES:** 0.035" wall,  $\frac{5}{8}$ " O.D.

Spacing: 1½" center to center, staggered

**FINS:** 0.010" plate type with die-formed ferrules

Spacing: 8 per inch

**SURFACE:** Total: 10,650 sq. ft.

Primary: 558 sq. ft.

**CASING:** Air tight at 60 inches W. G.

**OPERATING PRESSURE:** 1500 p.s.i.

**WEIGHT:** 5100 lb. dry

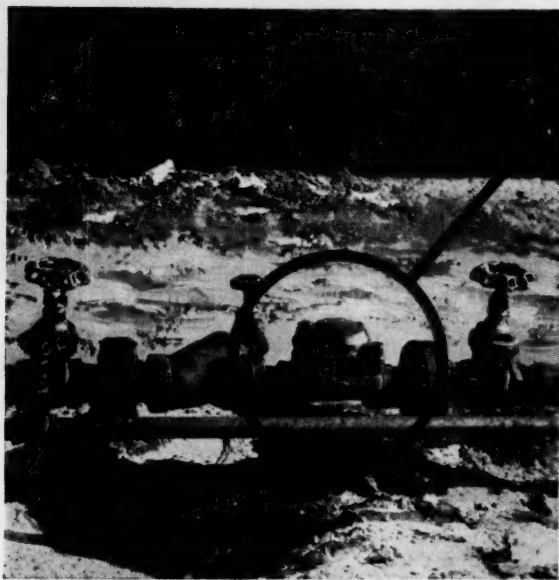
# Marlo coil co.

SAINT LOUIS 11, MISSOURI

Quality Air Conditioning and Heat Transfer Equipment Since 1925

# Y

from **Yarnall-Waring Company, Philadelphia 18, Pa.**  
 BRANCH OFFICES IN 19 UNITED STATES CITIES • SALES REPRESENTATIVES THROUGHOUT THE  
 WORLD • STEAM TRAPS STOCKED AND SOLD BY 270 LOCAL INDUSTRIAL DISTRIBUTORS



## THIS STEAM TRAP WILL DISCHARGE 25,500 LBS. OF CONDENSATE PER HOUR

This is a typical installation of a Yarway Series 40 Impulse Steam Trap—a trap designed specifically to gobble up extra heavy condensate loads.

The trap is a No. 48, 2½" size, and is installed on a suction heater connected with an 86,000 barrel tank containing fuel oil at a storage terminal. The operating pressure is 13 psi. At this pressure the trap has a capacity of 25,500 lbs. continuous discharge of condensate per hour.

At operating pressure of 100 psi, the trap's capacity is 62,000 lbs. per hour.

### CAPACITY—PLUS

Capacity isn't the whole story on Yarway Series 40 Steam Traps. Like all Yarway Impulse Traps, they offer advantages like quick heat-up, even temperatures, small size, good for all pressures, non-freezing.

Series 40 traps also feature high temperature discharge characteristics, excellent low pressure operation, no airbinding, operation against back pressures up to 40%, and stainless steel construction.

You can get Yarway's latest steam trap Bulletin T-1743, or arrange for a free 60-day trial of a Yarway Impulse Trap, by writing to Yarnall-Waring Company or contacting your local Industrial Distributor.



Yarway ½" No. 40 Impulse Steam Trap (shown actual size). Also available in ¾", 1½", 2" and 2½" sizes.

### YARWAY OFFERS IMPULSE STEAM TRAPS FOR THESE SPECIFIC OPERATING CONDITIONS

AVERAGE  
CONDENSATE  
LOADS



Series 60

EXTRA HEAVY  
CONDENSATE  
LOADS



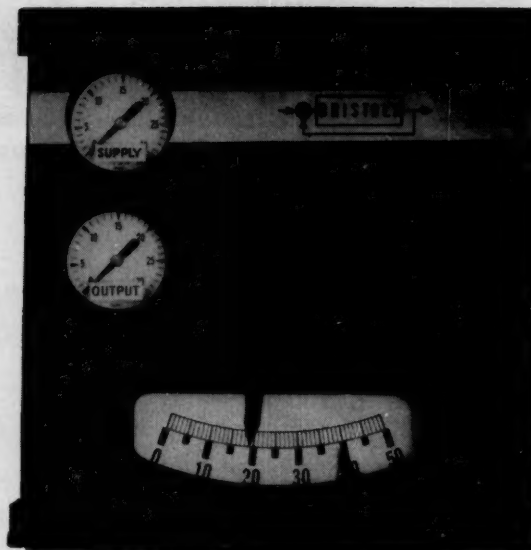
Series 40

LIGHT  
CONDENSATE  
LOADS



No. 30





## Series 624 A/D\* pneumatic controller features simplicity and high control stability

- Simple modular design for ease of servicing
- High control stability for closer process control
- Designed for batch-type and continuous processes
- Proportional and proportional-plus-reset control models available

Top control performance with maximum simplicity plus standard Bristol precision measuring elements—those are the key features of the Bristol Series 624 Controller. The 624 uses the same renowned elements that have earned such a reputation for accuracy and dependability on other Bristol automatic controlling and recording instruments—perfected through wide experience and many years of development.

Self-contained modular design of the control unit speeds servicing. The whole modular unit, consisting of an aluminum casting with working parts made of stainless steel, Ni-Span C, and Neoprene diaphragms, can be removed by taking out only two screws and a link.

Outstandingly compact, the aluminum instrument case (only 8" x 8" x 5" overall) is completely weatherproof. It is designed for either flush, surface, panel, or valve mounting. Attachments for pipe mounting (2-inch pipe) are available. Write for complete data on the versatile and economical 624 A/D. The Bristol Company, 109 Bristol Road, 035 Waterbury 20, Conn.

\*Advanced Design

### CONTROLLERS OFFERED FOR:

**PRESSURE AND VACUUM:** Ranges from full vacuum to 10,000 psi.

**TEMPERATURE:** Ranges from  $-100^{\circ}\text{F}$  to  $+1000^{\circ}\text{F}$ .

**FLOW AND DIFFERENTIAL PRESSURE:** With mercury-type manometer and dry-type differential unit.

**LIQUID LEVEL:** With bulb unit and mercury manometer and dry-type differential unit.

**HUMIDITY:** Zero to 100% relative humidity.

### CONTROL UNIT CHARACTERISTICS:

**PROPORTIONAL BAND:** 0-400% continuously adjustable, direct- or reverse-acting.

**RESET:** 0.1 to 50 repeats per minute.

**AIR PILOT:** Non-bleed type.

**PILOT CAPACITY:** 3.0 scfm.

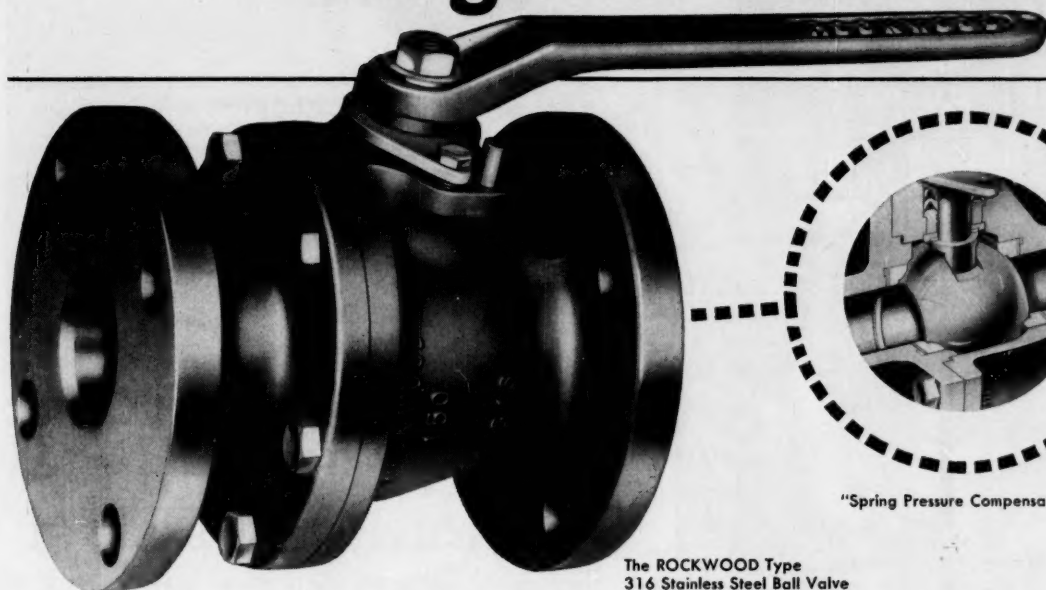
**FREQUENCY RESPONSE:** Flat to 300 cycles per minute.

**TEMPERATURE STABILITY:** Less than 0.25% change in the output pressure for  $90^{\circ}\text{F}$  temperature change.

**MATERIAL:** Aluminum housing; 316 stainless steel internal parts; Ni-Span C feedback element.

**BRISTOL** ... for improved production through measurement and control  
AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

# NEW... Today's "Tightest" and Toughest Ball Valve!



"Spring Pressure Compensated" \*\*

The ROCKWOOD Type  
316 Stainless Steel Ball Valve

Here's the new 316 stainless steel ball valve that not only gives you maximum corrosion resistance, but also *positive* assurance of leakproof service!

*It's Tightest* because exclusive spring rings back up its twin Teflon\* seats . . . *automatically* compensate for pressure variations, wear, cold-flow deformation and temperature effects. With flow in either direction . . . under vacuum or 600 psi . . .

seats always hug the ball.

*It's Toughest* because it's made with integrally cast flanges or screw ends. They *stay* leakproof even under constant vibration.

You get all the other Rockwood features, too: smooth, full round flow; easy  $\frac{1}{4}$  turn opening and closing; dead tight sealing without lubrication; and many more. For use at temperatures from  $-65^{\circ}\text{F}$  to

$350^{\circ}\text{F}$ , the Type 316 can be easily modified for cryogenics applications. Always tight in vacuum service, too. Handles air, alcohols, fuel and inert gases, water glass and many other fluids. For service up to 600 psi. 4 models available. Sizes  $\frac{3}{8}$ " through 2". Send coupon for complete details. Tested and listed by Underwriters' Laboratories, Inc.

\*DuPont Reg. T.M. Teflon seals include seats and adjustable chevron stem packing. Also available with nylon or synthetic rubber seals.

\*\*Patent Pending

## ROCKWOOD BALL VALVES

**FULL, ROUND FLOW**

Distributors in all principal industrial areas

### ROCKWOOD SPRINKLER COMPANY

A Division of The Gamewell Company • Subsidiary of E. W. Bliss Company  
268 Harlow Street, Worcester 5, Massachusetts

Please send full details on the new Type 316 Stainless Steel Ball Valve

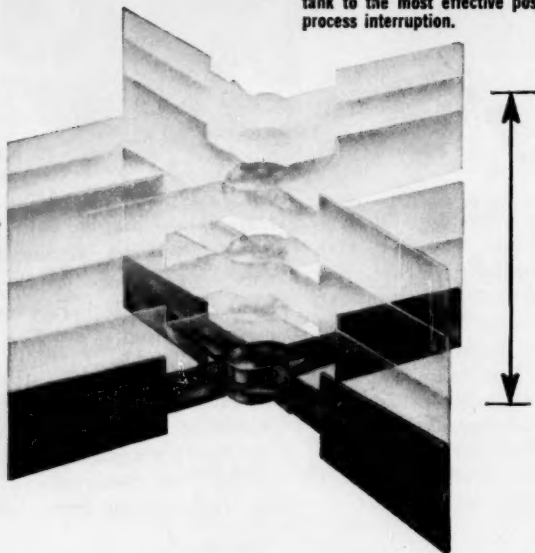
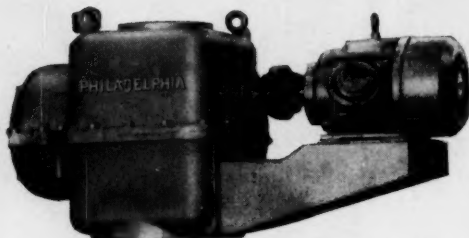
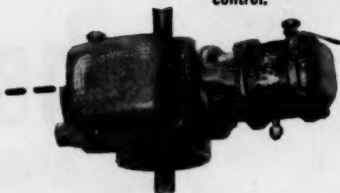
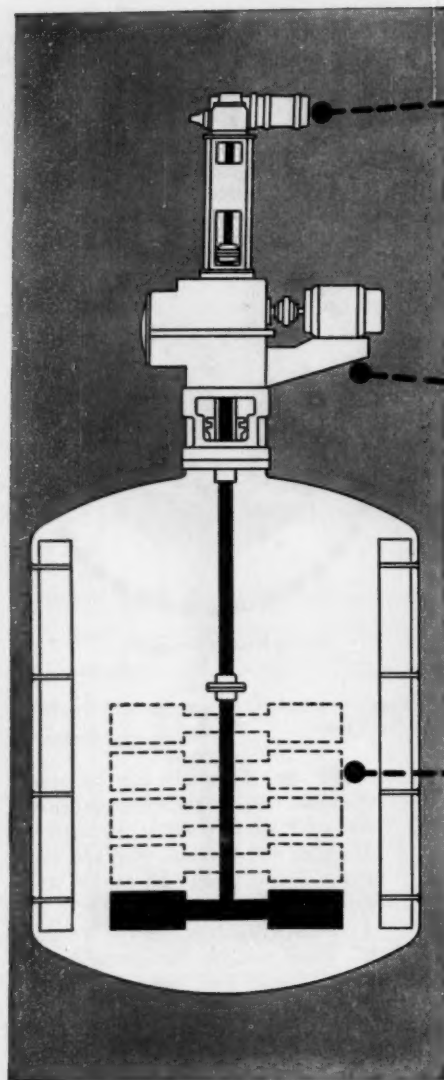
Name ..... Title .....  
Company .....  
Street .....  
City ..... Zone ..... State .....

# NOW...you can raise and lower mixing impellers with no process interruption...

Philadelphia Limitorque raises and lowers mixer shaft—either automatically or by push button control.

Philadelphia mixer drive rotates shaft—applies full torque at all shaft positions.

Mixing impeller can be raised or lowered in the tank to the most effective position... with no process interruption.



This combination of Philadelphia Mixer power transmission components gives you optimum mixer performance at all times. Mixing can continue at full tank pressure while impeller position is changed, and there is no danger of product contamination because it can be done without opening the tank.

Many processors are already taking advantage of this unusual mixer design feature. Why not learn how Philadelphia lifting-lowering mixers can improve the effectiveness of your mixing operations. For full information, send for Bulletin LL-60.

## philadelphia mixers

PHILADELPHIA GEAR CORPORATION  
King of Prussia (Suburban Philadelphia), Penna.



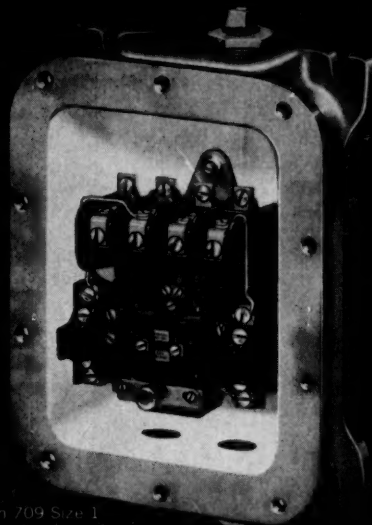
## For Maximum Protection in Hazardous Locations ...ALLEN-BRADLEY Quality Motor Control

In explosive atmospheres, removing bolted enclosures for inspection or maintenance can be both costly and time-consuming—especially if safety precautions require extensive preparation and shutting down operations prior to servicing. With the trouble free performance of Allen-Bradley quality motor starters, this trouble is eliminated.

The simplicity of the famous A-B solenoid design—with only **ONE** moving part—is your assurance of millions of dependable operations. And the double break, silver alloy contacts—used in *all* A-B controls—are always in good operating condition—*require no attention whatever!*

In addition, all A-B starters are equipped with two or three permanently accurate thermal relays that protect motors against dangerous overloads. And the reliability of these relays is unaffected by atmospheric conditions or length of time in service.

To guard your equipment, your operations, and your operating people, insist on Allen-Bradley—the motor control built to be installed and forgotten.



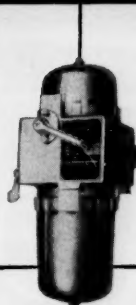
Bulletin 709 Size 1  
Solenoid Starter in  
NEMA Type 7 enclosure for  
hazardous gas locations



NEMA 4  
Watertight  
Weatherproof



NEMA 8  
Corrosive  
Hazardous Gas



NEMA 7-9  
with screw-type  
cover and base  
for Bulletin 713  
Combination Starter



NEMA 9  
Hazardous  
Dust Locations



NEMA 11  
Corrosive  
Gas Locations

# ALLEN-BRADLEY

Member of NEMA

Allen-Bradley Co., 1337 S. First St., Milwaukee 4, Wis. • In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

## QUALITY MOTOR CONTROL

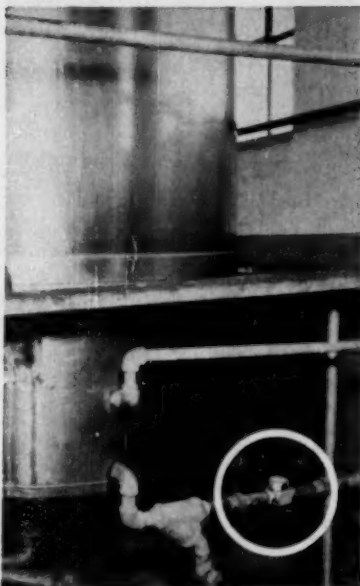


# SARCO TOPICS

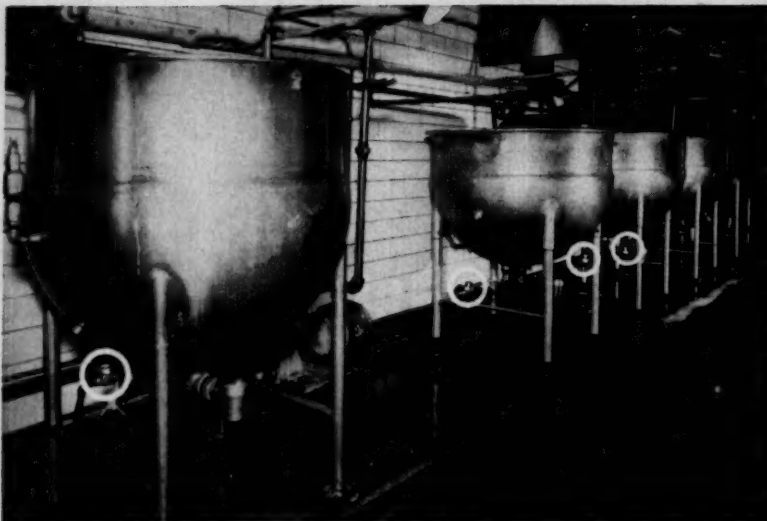
## How to reduce cooking time and trap maintenance in kettles and holding tanks

**College Inn Food Products Corp.** of Chicago faced a problem familiar to many food processors: excessive heat-up time for kettles and holding tanks, and time lost for steam trap maintenance. They found old-fashioned bucket traps at the root of this costly problem.

Specifically, College Inn wanted to shorten both cooking and recovery time in their 150-gallon jacketed kettles... cut heat-up time for both the kettles and their 1000-gallon holding tanks... materially reduce down-time for trap repairs or replacement.



Heat-up time on storage tanks like this one has been reduced approximately 20%. The 1" TD-50 trap on this application replaced a 1½" bucket trap.



With TD-50 traps installed on these kettle rows, down-time for trap maintenance is virtually nil — over years of service.

**These problems were solved** by installation of Sarco Thermo-Dynamic Steam Traps, Type TD-50 to replace bucket traps. On slow cook kettles the ½" size was installed; on fast cook kettles, the ¾" size; 1" traps went on the 1000-gallon storage tanks.

Results were evident at once: Heat-up and cooking time was reduced on all kettles. Where each kettle row had previously required two or three hours per week of shut-down for bucket trap service, maintenance has now dropped to practically zero. Some traps have been in constant service for three years without attention. These results, though noteworthy, are typical. They were achieved because the TD-50 always discharges condensate as rapidly as

it is formed; it cannot collect and slow down schedules.

Plant Engineer John Maurisak says: "I'm happy because of freedom from trap maintenance problems, and the cooks are happy because of the fast recovery of the kettles."

**Other food processing problems** will yield to Sarco TD-50's too. Where slugs of condensate and wet steam disturb processing, the TD-50 can be used to control moisture content automatically, easily. Kettle cold-spots caused by a faulty trapping system which does not discharge condensate and air adequately, can be cleared up easily with TD-50's. Other advantages include simplified piping, saved space (because TD-50's are much smaller than conventional traps), easily maintained cleanliness of surroundings.

4189

For information on Sarco Thermo-Dynamic Steam Traps, Type TD-50, contact your Sarco Sales Representative, district office, or distributor, or write.

SARCO COMPANY, INC.  
635 MADISON AVENUE, NEW YORK 22, N. Y.  
PLANT, BETHLEHEM, PA.

STEAM TRAPS • TEMPERATURE CONTROLLERS  
STRAINERS • HEATING SPECIALTIES



**ALL sizes**  
from 1 sq. ft. to 1000  
sq. ft. filtering area.

**ALL styles**  
flush plates & frames  
• recessed plates •  
hollow plates • solid  
center plates • retain-  
ing ring, packing ring  
& grooved joint plates.

**ALL materials**  
cast-iron • aluminum  
• bronze • lead • nickel  
• rubber • stainless  
steel • wood • glass  
reinforced resins, etc.

**Performance  
PROVED  
throughout  
ALL industries**

**SPERRY**

**in ALL ways...the simplest, most economical  
means of superior filtration!**

Recognizing that no single type filter press will satisfy all requirements, Sperry makes available the broadest combinations of design features to help you achieve maximum efficiency and economy.

Briefly—the Sperry Filter Press can be equipped with any type of plates—made of virtually any material—to handle any filterable mixtures—and most filter media—over a wide range of temperatures, pressures and capacities—with center, side or corner feed—open or closed delivery—for filtration of liquids, recovery of solids, clarification and decolorizing.

Sperry also manufactures a complete range of plate shifting and closing devices—enabling one man to control the entire operation.

**All this—at low first cost, low depreciation and minimum maintenance! Write for details or mail coupon for free Sperry catalog.**

#### **D. R. SPERRY & CO., Batavia, Ill.**

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**D. R. SPERRY & CO. Dept CE-60-2**  
Batavia, Illinois

- ☐ Send Free Sperry Catalog  
☐ Have your Representative Contact us



Name

Company

Address

City  State

# Armco ALUMINIZED STEEL

Gives Drying Ovens greater durability and efficiency



All sheet metal parts of this 108-foot long continuous dryer for wood fiber structural board are made of Armco ALUMINIZED STEEL Type 2. It is in operation at the Arkadelphia Plant of the Tectum Corporation.

For Durability,  
Strength  
and Economy



To insure efficient operation, durability, and economy, the manufacturer of this continuous dryer required a low-cost metal that would resist corrosion by moist atmosphere and would have high strength and rigidity.

Armco ALUMINIZED STEEL Type 2 met *all* requirements. That's why every sheet metal part is made of this special hot-dip aluminum-coated steel.

ALUMINIZED STEEL is ideal for drying and processing ovens because it is two metals in one with a unique combination of properties:

- The special aluminum coating resists corrosion by oven or outside atmospheres.
- Its steel base provides high strength and rigidity.
- About 80% of incident radiant heat is reflected by the surface of ALUMINIZED STEEL.
- Cost is low, only two to five cents per sq. ft. more than galvanized sheet steel, less than aluminum.
- Paint is not needed for durability.

Cut costs of *your* drying operations by specifying ovens made of Armco ALUMINIZED STEEL Type 2. Write us for information on this special aluminum-coated steel or, let us put you in touch with manufacturers who use it in their dryers. Armco Division, Armco Steel Corporation, 1341 Curtis Street, Middletown, Ohio.



Armco Division

# LET SK JET EJECTORS SIMPLIFY YOUR JOB

SK Jet Ejectors are outstandingly simple and reliable. There are no rotating parts to break, none to maintain. Jet ejectors are compact, low in cost. Because of their uncomplicated design, they can be made in many corrosion and erosion resistant materials. Easy to install and requiring little attention, they can be located in remote and inaccessible places. And, most often, they will perform two or more functions at the same time. Pump and heat. Entrain and scrub. Pump and mix. Compress and move.

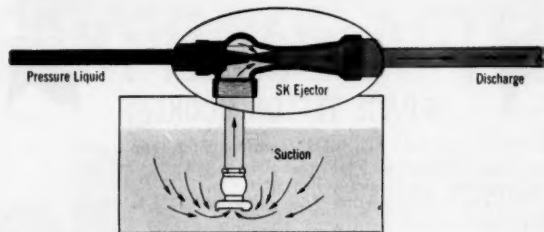


SK Jet Ejectors are worth knowing more about. Ask for Bulletin J-1. It gives brief data on types and functions.

## SK Liquid Jet Ejectors PUMP AND MIX SIMULTANEOUSLY

SK Liquid Jet Ejectors utilize the kinetic energy of a liquid under pressure to entrain, mix, and pump liquids or handle slurries and granular solids. Uses vary from pumping out a sump to mixing chemicals in proper proportions.

Some user benefits: (1) *economy*—a 2-inch, bronze unit costs only \$51.00; (2) *maintenance-free service*—simple construction and lack of moving parts makes supervision unnecessary; (3) *availability*—stocked in popular sizes in Pennsylvania, Texas, California; (4) *adaptability*—made and stocked in cast iron, bronze, stainless steel, asbestos-filled resin, PYREX brand tubing, and PVC.



For details—ask for Bulletin 2M

JET APPARATUS: Ask for Condensed Bulletin J-1.

ROTAMETERS & FLOW INDICATORS: Ask for Condensed Bulletin M-1.

VALVES: Ask for Condensed Bulletin V-1.

HEAT TRANSFER APPARATUS: Ask for Condensed Bulletin HT-1.

GEAR PUMPS: Ask for Bulletin G-1.

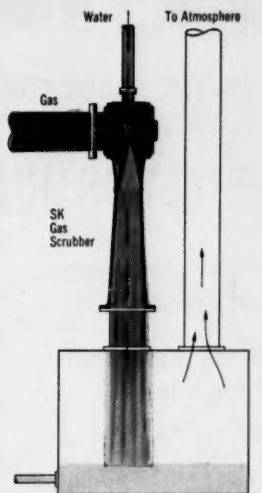


## Schutte and Koerting

COMPANY

MANUFACTURING ENGINEERS SINCE 1876  
2217 State Road, Cornwells Heights, Bucks County, Pa.  
Phone: MERCURY 9-0900 TWX: Cornwells, Pa. 69-U

## SK Ejector-Venturi Scrubbers SOLVE FUME PROBLEMS

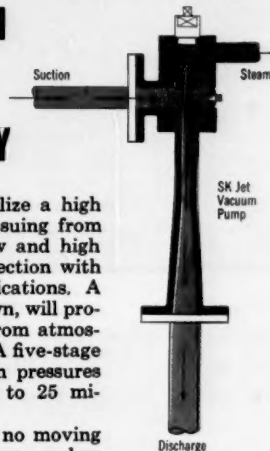


For details—ask for Bulletin 4R

SK Gas Scrubbers operate on the jet principle. Use a pressure liquid, issuing through a spray nozzle, to create a draft, draw gases, vapors, dusts into the unit, scrub them, and discharge clean air.

These scrubbers are (1) *economical*—low in initial and operating cost compared with other types; (2) *efficient*—see data in Bulletin 4R; (3) *readily available*—stocked in popular sizes in Pennsylvania, Texas, California; (4) *adaptable*—made and stocked in cast iron, asbestos-filled resin, PVC, and stoneware to meet service conditions.

## SK Steam Jet Vacuum Pumps PRODUCE HIGH VACUUM ECONOMICALLY



SK Vacuum Pumps utilize a high velocity jet of steam, issuing from a nozzle, to provide low and high vacuum service in connection with numerous process applications. A single-stage unit, as shown, will provide suction pressures from atmosphere to 1.5 in. Hg abs. A five-stage unit will provide suction pressures from 0.25 mm Hg abs to 25 microns Hg abs.

Simple in design, with no moving parts, SK Vacuum Pumps are low in cost, economical to operate. They are available in popular sizes in various materials from stock in Pennsylvania, Texas, California.



For details—ask for Bulletin 5E



# ENGINEERING

NEWS YOU CAN USE ABOUT ENGINE AND COMPRESSOR PERFORMANCE

## TEFLON\* COMPRESSOR RINGS... for special applications

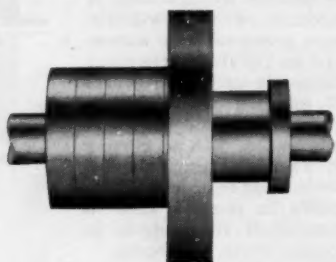
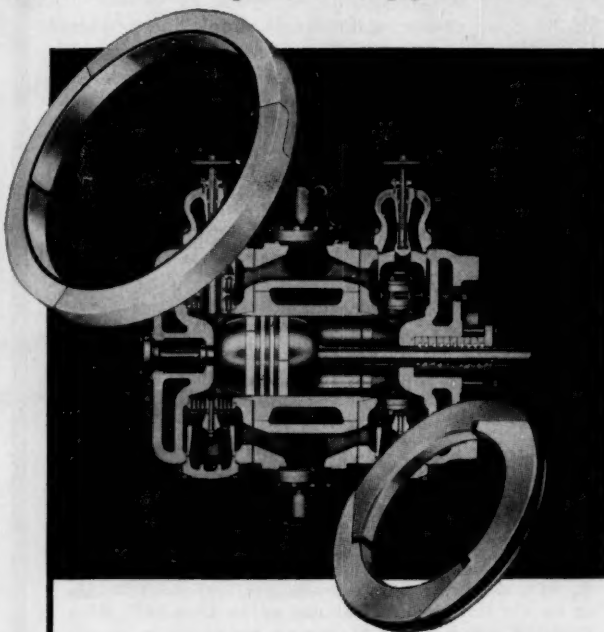
- TEFLON eliminates or minimizes compressor lubrication
- TEFLON is inert to most harmful chemicals and solvents

Cook-engineered Teflon packing and piston rings now make it possible to reduce or completely eliminate compressor lubrication. Because of its extremely low coefficient of friction—its toughness and resiliency—Teflon is suitable for both lubricated and non-lubricated ring service.

And just as important, Teflon is completely inert to most chemicals and solvents—thus prevents costly product contamination or other damage which might result with ordinary ring materials.

If your special processing applications demand "borderline" compressor lubrication, you'll want to investigate Cook's Teflon rings. You can get them any size. And they are available in many special Teflon blends, depending on your application. Ask a C. Lee Cook representative to give you the details.

\*Teflon is a du Pont product of thermoplastic tetrafluorethylene resin.



### NEW PACKING DESIGN TAKES HEAT OFF TEFLON RINGS

This unique packing design now being developed by Cook keeps Teflon rings cool! It is a new idea for application where Teflon's qualities are needed, but where normal operating conditions develop too much heat for conventional designs.



### SEND FOR FREE 6-PAGE TEFLON BOOKLET

If you would like more complete information about new Teflon packings and Teflon piston rings for your specific applications, just write: C. Lee Cook Company, 958 South 8th Street, Louisville 3, Kentucky.

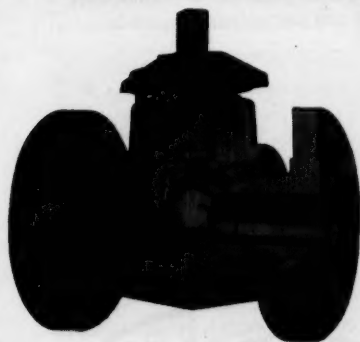
## C. LEE COOK

DIVISION OF **DOVER** CORPORATION

*Rings and Packings Since 1911*

## W-K-M's ACF Ball Valves...

# LEAKPROOF AFTER 600,000 CYCLES!



Proved in the laboratory, and in over five years of field service with such difficult ladings as acetone, propane, vinyl chloride, and lime and soda-ash slurry, W-K-M's ACF Ball Valve has earned a reputation for extra long life *without lubrication*. For example —

In one test, W-K-M opened and closed a 2" standard production model under pressure 600,000 times. The valve still sealed tight, and there was no measurable wear on either the chrome-plated ball or the Teflon seats!

W-K-M's rugged ACF Ball Valves are available in carbon steel to ASA 300 lbs. (some sizes 600 lbs.), and in semi-steel, ASA 200 and 400 lbs. WOG.

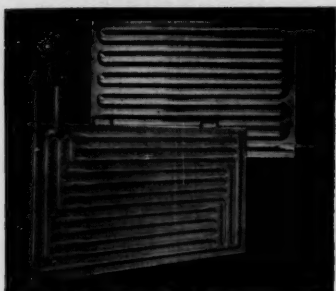
Write for Catalog 1000.

Conduit is full-bore; Teflon stem gaskets and seats are sealed from the lading flow.

**WHEN SO MUCH DEPENDS ON A  
VALVE . . . SPECIFY ACF BALL VALVES**

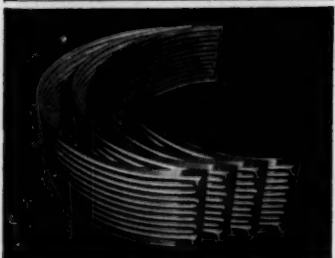
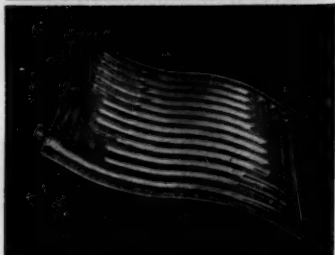
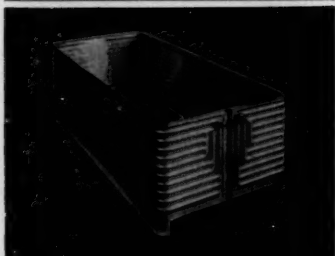
# W-K-M

**DIVISION OF OCS INDUSTRIES**  
INCORPORATED  
P. O. BOX 2117, HOUSTON, TEXAS



# PLATECOIL®

"STANDARD" STYLES OR SPECIALLY  
FORMED AND FABRICATED



## = a SOLUTION

TO DIFFICULT  
HEAT TRANSFER PROBLEMS

Now you can apply the engineering, installation, operational and maintenance advantages of PLATECOIL to more tank and process heating and cooling problems than ever before. Standard units with exclusive "MULTI-ZONE" pass design for faster heat-up and temperature recovery or serpentine pass arrangement satisfy many requirements. These "standard" styles, available in a wide variety of sizes can be factory-fabricated into banks to fit the application. PLATECOIL can be formed and rolled to specified diameters or even fabricated to form tank walls.

PLATECOIL provides a "packaged" answer to many heat transfer problems, avoiding costly engineering and fabricating of pipe coils. Units are easy to install and maintain—with simple connections, light weight, and streamlined surfaces. High heat transfer capacity permits compact, space-saving units.

Both "standard" and specially built PLATECOIL are available in mild steel, stainless steel, Inconel, Monel, Ni-O-nel, Hastelloy B, C and F, Nickel and other weldable materials. Operating pressures up to 250 psig. Safety factor—5 to 1. Double embossed or one side flat. Complete engineering data and assistance available.



Ask for Bulletin P61.



Tranter Manufacturing, Inc.

LANSING 9, MICHIGAN

**PLATECOIL®**  
DIVISION



Heat exchangers stocked  
at B&G plant for  
serving rush orders

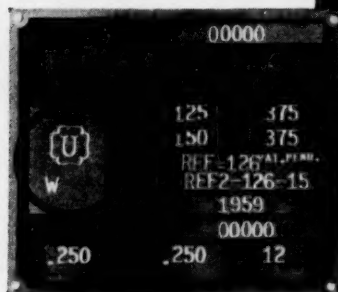
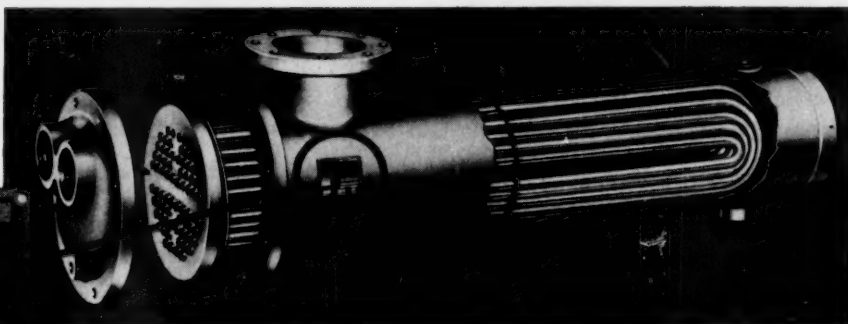
## NEED A HEAT EXCHANGER IN A HURRY?

All facilities for heat exchanger manufacture are available under one roof at the B&G plant, where assembly line procedures permit building an inventory of stock parts and complete units. B&G Heat Exchangers are not only engineered to top efficiency but are constructed to the highest standards of quality and safety as required by the A.S.M.E. Unfired Pressure Vessel Code. Form U-1 Manufacturers' Data Report for Unfired Pressure Vessels is

furnished with each unit as required by the provisions of the A.S.M.E. Code.

B&G Heat Exchangers are made in both U-bend and straight tube, floating tube sheet models. A comprehensive stock of U-bend exchangers is available for fast shipment. Refrigeration condensers, evaporators, liquid receivers and suction line heat exchangers are also maintained in factory stock.

**STAINLESS STEEL UNITS**  
B&G Heat Exchangers are available with Type 304 or 316 stainless steel tubes, tube sheets and heads.



All B&G Heat Exchangers are stamped with A.S.M.E. "U" Symbol. Send for brochure, "The A.S.M.E. Story".



**BELL & GOSSETT**  
C O M P A N Y

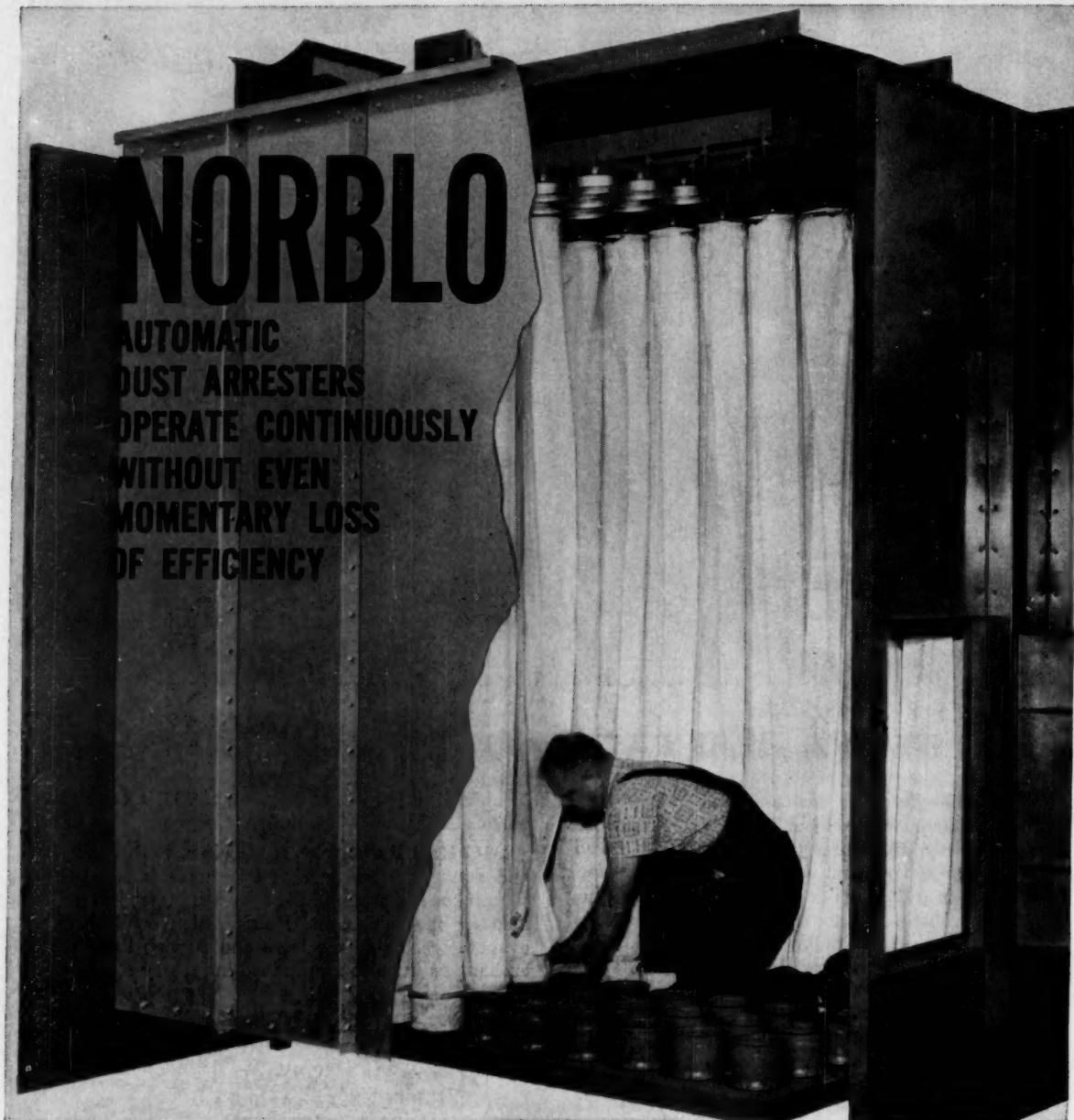
Dept. GN-14, Morton Grove, Illinois

Canadian Licensee: S. A. Armstrong, Ltd., 1400 O'Connor Drive, Toronto 16, Ontario



# NORBLO

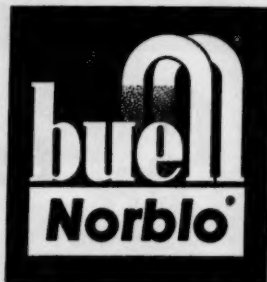
AUTOMATIC  
DUST ARRESTERS  
OPERATE CONTINUOUSLY  
WITHOUT EVEN  
MOMENTARY LOSS  
OF EFFICIENCY



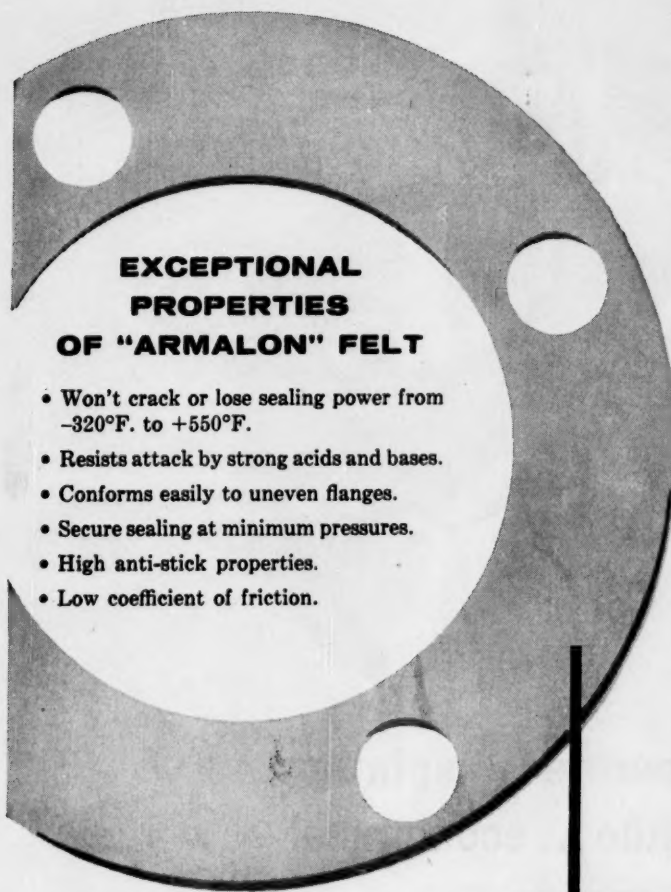
Periodic cleaning, repair or replacement of bags, and minor maintenance can be accomplished while the collector remains in operation. One compartment, as shown above, can be isolated in the Norblo design, with all mechanical parts outside the gas stream. Continuous cyclic shaking, by compartment, allows operation without interruption. ■ This is why in modern plant operations you'll find an increasing preference for Norblo Automatic Bag Arresters. Where efficient production requires continuous operation more and more

industries specify Norblo Dust Arresters. Over 80% of the cement industry relies on Norblo equipment for drying, grinding and finishing operations. ■ Buell-Norblo equipment can play an essential part in your process. Write for complete

information on any type of dust collection problem. Buell Engineering Company, Inc., Dept. 12B, 123 William Street, New York 38, New York. Northern Blower Division, 6411 Barberton Avenue, Cleveland, Ohio. Electric Precipitators • Cyclones • Bag Collectors • Combination Systems • Fans • Classifiers.

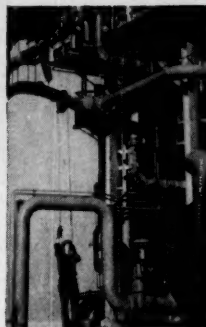


# Gaskets exposed to harsh chemicals, extreme temperatures demand the remarkable resistance properties of Armalon® felt



## EXCEPTIONAL PROPERTIES OF "ARMALON" FELT

- Won't crack or lose sealing power from -320°F. to +550°F.
- Resists attack by strong acids and bases.
- Conforms easily to uneven flanges.
- Secure sealing at minimum pressures.
- High anti-stick properties.
- Low coefficient of friction.



If harsh chemicals and -320°F. to +550°F. temperatures force you to replace gaskets every few weeks, you need gaskets made of Du Pont "Armalon" TFE-fluorocarbon resin-impregnated felt. This unique gasketing material gives months (even years!) longer service, can drastically cut replacement costs and work interruptions.

Just look at these remarkable examples of how "Armalon" felt gaskets extend service life under extreme operating conditions:

**Lasts over 700% longer!** "Armalon" gaskets handling 99.3% sulfuric acid at 200°C. are still in service after 18 months. Conventional materials frequently had to be replaced within a week.

**HNO<sub>3</sub> fumes at 170°C. and 97 psi.** were still satisfactorily carried in stainless-steel pipes gasketed with "Armalon" after 7 months. Other materials had to be replaced every 10 to 15 days.

**After 15 months,** ammonium sulfate and sulfonic acid are still being processed in a centrifuge containing a gasket of "Armalon". Previous materials were replaced every two to three weeks.

These are just three of the many examples of exceptional performance of "Armalon" illustrated in the Du Pont booklet "Armalon"—for gasketing under extreme conditions. Send for your free copy and see how you can end troublesome gasketing problems. Clip coupon or write Du Pont . . . there's no obligation. E. I. du Pont de Nemours & Co. (Inc.), Fabrics Division, Wilmington 98, Delaware.

"Armalon" is Du Pont's registered trademark for its TFE-fluorocarbon-resin-impregnated felts.

## DU PONT INDUSTRIAL COATED FABRICS



BETTER THINGS FOR BETTER LIVING THROUGH CHEMISTRY

**FREE BOOKLET** tells you how you  
can reduce gasketing costs . . .

E. I. du Pont de Nemours & Co. (Inc.)  
Fabrics Division, Dept. CE-02, Wilmington 98, Delaware

Please send me a free copy of "Armalon"—for gasketing under extreme conditions.

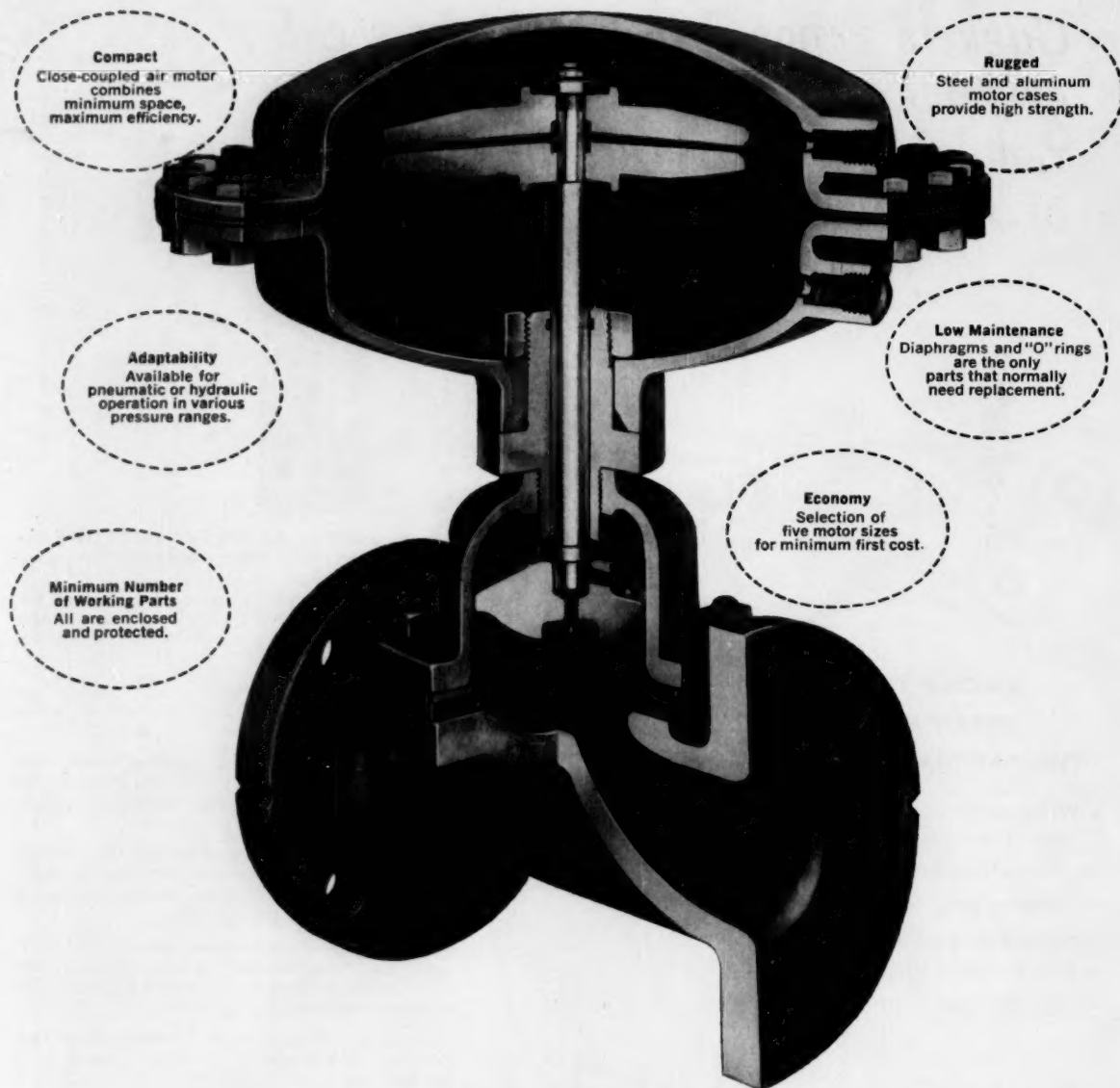
Name \_\_\_\_\_ Position \_\_\_\_\_

Company \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_





## Why this power-operated diaphragm valve is so versatile...economical

The Grinnell double-acting air motor teams up with the Grinnell-Saunders Diaphragm Valve to provide a power-operated valve that's versatile and economical! What's more, the "Grinnell" name on each part assures you of the

highest quality throughout the completed unit. Available in a range of motor sizes for 1/2" through 6" valves. Learn how Grinnell power-operated valves can help *your* installation. Write Grinnell Company, Providence 1, R. I.

### You get a wide choice of accessories too!

- Handwheel closing device
- Positioner
- Adjustable travel stop
- Adjustable opening stop
- Position indicator
- Microswitches

## GRINNELL-SAUNDERS DIAPHRAGM VALVES

GRINNELL COMPANY, PROVIDENCE 1, R. I. • BRANCH WAREHOUSES AND DISTRIBUTORS FROM COAST TO COAST  
PIPE FITTINGS • VALVES • PIPE HANGERS • PREFABRICATED PIPING • UNIT HEATERS • PIPING SPECIALTIES





bone dry

If your plant location is as dry as the sand this Indian is "painting" with, you won't have any caking caustic problems . . . ever. If it isn't, your best move is to buy Wyandotte Flo-chilled\* Anhydrous Caustic Soda. This special grade flows readily, even in hot, humid weather—which means you can depend on it every month of the year regardless of your location. Flo-chilling is the difference! You pay no more for Flo-chilled Caustic than for ordinary grades, yet you save money through faster production and less down-time due to caking. Try it now.

Wyandotte  
Flo-chilled Caustic



MAIL THIS FOR FACTS ON FLO-CHILLED CAUSTIC

ANOTHER  
**WYANDOTTE**  
KEY CHEMICAL

CUT OUT, FOLD, STAPLE, AND MAIL TODAY!

*Yes*

☐ Send free brochure on Wyandotte Flo-chilled Anhydrous Caustic Soda ☐ data on other anhydrous grades ☐ brochure on economies of 50% vs. 74% liquid caustic. Please include price sheets on ☐ carload quantities ☐ L.C.L. quantities.

I use caustic for \_\_\_\_\_

NAME \_\_\_\_\_

TITLE \_\_\_\_\_

COMPANY \_\_\_\_\_

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## Chementator

### Ethylene-to-acetaldehyde process scheduled for U. S. debut

Celanese Corp. has announced that it is licensing the Aldehyd GmbH. acetaldehyde process, first described two years ago (*Chementator*, June 1, 1959, p 33). Aldehyd GmbH. is jointly owned by Germany's Farbwerke Hoechst and Wacker Chemie; these firms are already using variations of the process in two 24,000-ton/yr. plants. And it is also being used by Italy's Societe Edison and Mexico's Pemex.

Celanese will build a "multimillion dollar" acetaldehyde plant on a 1,000-acre site near Bay City, Tex. Construction will start in second quarter of '61, will be completed within a year. Also to be built at Bay City: a unit for making 2-ethyl hexanol, used in vinyl resins.

Of the two versions of the Aldehyd process, it's not known which Celanese has picked. In the first one, ethylene reacts with water and a palladium dichloride catalyst to form acetaldehyde along with HCl and metallic palladium. Spent catalyst is then regenerated with air in a second reactor. The other version of the process uses one reactor and depends upon oxygen instead of air.

---

*General Electric has come up with a wiped-film evaporator for water desalination. Advantages: high heat-transfer rates, minimum carry-over of salt in the condensate because thin sea water film allows bubble-free distillation.*

---

### Job prospects for ChE's remain good despite general unemployment

Chemical engineers are not having too much trouble locating jobs in most of the U.S., despite

the general rise in unemployment. This is the conclusion of a survey conducted by *CE's* news bureaus in 10 major population centers.

The survey did find that a few profit-squeezed companies are laying off engineers—especially in research and development—but this is not as widespread as it was in the black days of '58, which saw wholesale reductions in engineering staffs.

Perhaps the employment situation is best typified by a big chemical company that had contacted the New York state employment office looking for several chemical engineers. A few days later, however, the company called back to cancel the request because it had received a directive to hold the line on costs.

The West Coast, South and Southwest all seem to be supplying relatively full employment for ChE's. The Northeast and Midwest have more engineering unemployment, but the situation is described by employment officials as "not serious." Though there have been a few large-scale cutbacks, most companies that are doing some belt tightening are using techniques such as foregoing salary increases and not replacing engineers who leave.

Some areas even report a shortage of engineers, especially among recent graduates. Many firms would like to assign some of their more routine chores to younger men to free their experienced engineers for more-productive assignments.

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### Another dealkylation process bids for role in benzene bonanza

Adding to the mounting activity in petrochemical benzene, Houdry Process Corp. has announced a new hydrodealkylation process that converts toluene or xylene into benzene. First licensee: Crown Central Petroleum, which will build a 17-million-gal./yr. plant at Pasadena, Tex.

Houdry's process is the first to challenge the Ashland-UOP Hydeal route, which has been

**CROUSE/HINDS**

**WJB and WJBF Series  
JUNCTION CONDULETS®**

**NOW  
AVAILABLE  
IN 28  
DIFFERENT  
SIZES...**



Heavy-duty junction boxes have to be more than mere splice points. That's why the Crouse-Hinds WJBF floor-Condulet is built to resist wash-down water, atmospheric moisture, dust and alkaline atmospheres — conditions that will reduce an ordinary junction to fireworks long before the Fourth of July. Hot-dip galvanized, cast Feraloy construction does the job.

And you can get the same neoprene-gasketed moisture protection in the surface-mounted raintight Crouse-Hinds

WJB Condulet. Both types are available in cast aluminum, sold at the same price as Feraloy.

28 sizes of each type are available, ranging from 4" x 4" x 4" to 24" x 24" x 12", with or without mounting feet. The number and size of conduit entrances can be specified or Condulets can be drilled and tapped in the field. For more information check your Crouse-Hinds Distributor.

**HINDS**  
NEW YORK

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Crouse-Hinds of Canada, Ltd., Toronto, Ont. Crouse-Hinds-Domex, S. A. de C. V. Mexico City, D. F. Peterco, Sao Paulo, Brazil

the only hydrodealkylation flowsheet available for licensing. (Sun Oil, Humble and Union Oil all have developed proprietary processes.) But there are strong indications that a third dealkylation process will soon be up for licensing.

In the Houdry process (called Detol) toluene or xylene is heated under pressure with hydrogen, then flows to the catalytic reactors. Catalyst is said to be similar to reforming catalyst (but cheaper) and is not affected by sulfur. Reactor effluent is cooled by heat exchange, then benzene and unconverted feed are condensed. Stream is stabilized and clay-treated, then fractionated to remove benzene and unreacted feedstock.

Typical yield is about 0.8 gal. benzene/gal. toluene; estimated operating cost in the Gulf area is pegged at 1.63¢/gal. Product has a freeze point of 5.4 C., meets acid-wash and corrosion tests, contains less than 1 ppm. thiophene.

In the new Crown plant, Detol unit feedstock will first be subjected to Udex extraction that will wring any benzene out of the stream, raise total benzene output to 21-23 million gal./yr.

## Chromium diffusion technique turns carbon steel into ersatz stainless

Alloy Surfaces Co., Wilmington, Del., is starting, in cooperation with Lukens Steel, a development program designed to introduce engineers to what is described as a new construction material: ordinary steel with a thin 50% chromium coating. This places it between carbon steel and stainless, both from a price and performance standpoint.

The chrome coating is more corrosion resistant than conventional steels and has good oxidation resistance up to 1,400 F. Main limitation in corrosive service: erosive environments quickly wear through the thin coatings. Currently, heavy plate, sheet and tubing can be furnished on a developmental basis. The chromium coating can be applied for as little as 2¢/sq. ft./mil of thickness.

Alloy Surfaces is licensing its diffusion process, called Alplatizing, to selected fabricators and steelmakers throughout the country. Firm sells its special coating material—Alphalloy—to its licensees. Alphalloy is a special ferrochrome ore charged with chromous halide and "other chemicals."

Part to be coated is placed in a retort along with lumps of Alphalloy. As the retort is heated, a purging atmosphere is generated; then, at a higher temperature, chrome diffuses gaseously from the ore to the metal work. The Alphalloy can be used over again until the halide charge is expended, at which time it can be recharged and reused.

Chromalloy Corp. and Haynes Stellite also have diffusion processes. But neither the Haynes nor Chromalloy processes are available for licensing, and both firms are concentrating on high-temperature coatings for aircraft engines, with less emphasis on process applications.

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*Marquardt Corp. says it has come up with a design for a nuclear power plant in the 5,000-20,000-kw. range that is competitive with conventional steam plants. Key: use of the organic coolant, diphenyl, as the working fluid in the turbine. Diphenyl can be expanded without condensation, eliminating moisture separation and vapor reheat required by steam turbines.*

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## Using bleach-plant caustic can shave sulfite pulping costs

Most talked-about paper given at the recent meeting of the Canadian Pulp & Paper Assn., in Montreal, was disclosure of a mixed sodium-ammonium sulfite pulping process developed by Columbia Cellulose Co., Prince Rupert, B. C. Main reason for the interest: spent bleach-plant caustic soda augmented with ammonia made up the base for the cooking acid. On a commercial scale, this would be far more economical than pulping with either straight ammonia or commercial caustic soda.

Results of pilot-plant runs showed that mixed-base cooking gave a product with permanganate number, alpha-cellulose content and screen-reject characteristics equivalent to regular ammonium- and sodium-based pulps and superior to direct-steamed calcium-based raw stock. Cooking times with the mixed-base acids were slightly longer than with conventional pulping liquors because the hemicellulose in the

(Continued on page 78)



# EXCLUSIVE SAVINGS

## PRE-TESTED!



Future savings in vacuum tumble drying can be previewed at P-K's Vacuum Tumble Dryer Pre-Test Laboratory. Pre-testing realistically points the way to economies in drying time, solvent recovery, process simplification and handling costs. It helps gain management and purchase approval. And it permits modification of controls, condenser, vapor line, receiver and other components to the individual needs of your process and product.

## EXCLUSIVE COMBINATION!

Only P-K Vacuum Tumble Dryers offer pre-tested, pre-packaged savings. In pre-testing, results are predicted with a detailed procedure report and test samples. In pre-packaging, a single source of responsibility delivers a tailored, thoroughly proved assembly at a cost far less than a do-it-yourself project.

Compared to tray drying, the advantages of P-K Vacuum Tumble Dryers are overwhelming. Drying is many times faster. Expensive solvents are condensed and recovered. And caking that requires separate pulverizing and screen-

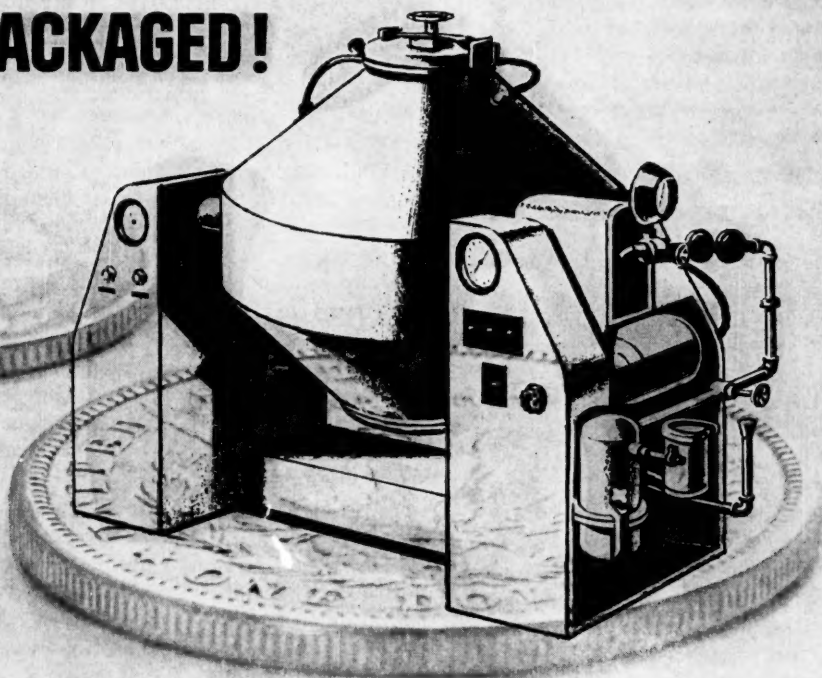
ing steps is eliminated. This greatly reduces handling. It often saves enough in labor costs to justify investment. It safeguards against product contamination.

In design, too, P-K Vacuum Tumble Dryers offer important features. Typical examples: A series of filter precautions that protect the vacuum pump from solids; an optional pin-studded intensifier that produces extra fine powder during drying.

Why not investigate P-K Vacuum Tumble Dryers more completely? Our pre-test facilities are at your disposal. Send or bring your test material. For complete information mail the coupon or call George Sweitzer at our East Stroudsburg Headquarters, 122 Hanson Street.

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bleach-plant caustic tends to tie up some of the sodium values. The hemicellulose gives better delignification of wood chips, however, via a mechanism that is not entirely understood.

Two mixed-base acid compositions were used in the experiments, prepared from used caustic and ammonia by blending in sodium sulfite and ammonium sulfite solutions. One contained 0.4% combined  $\text{SO}_2$ , as sodium sulfite, and 0.5% combined  $\text{SO}_2$ , as ammonium sulfite. Ratios in the second solution were 0.6% and 0.3%, respectively. Both solutions were fortified with  $\text{SO}_2$  gas to give acids with 7% total  $\text{SO}_2$ .

## Tempo quickens as more companies cut into synthetic paper market

Interest in synthetic papers, growing for a decade in the U.S., is spreading to Europe. Switzerland's Zuercher Papierfabrik has just started commercial production of nylon-based paper—much stronger and more durable than cellulose paper. And Du Pont, which recently announced a breakthrough in synthetic paper-making, reports it has received a startling number of inquiries from Europe.

Du Pont, by developing a new polymer form, has eliminated the need for liquid binders in synthetic papers. The company came up with an irregular fiber particle—called a fibril—that can be made from acrylics, polyesters or polyamides. Mixed in water with conventional fibers of these synthetics, the fibrils form a slurry similar to conventional paper pulp. Sheet formed on a paper machine from this slurry is simply exposed to heat and pressure to produce the finished synthetic paper.

The Swiss have not revealed whether their paper, called Syntosil, requires conventional binder or not. A synthetic paper announced last year by Feldmuehle—West Germany's largest paper producer—is conventionally bound, as are nylon and acrylic papers developed by such companies as Riegel Paper and Chemstrand.

Advantages of these new papers are such properties as high tensile strength, resistance to heat and chemicals, and good electrical characteristics. But synthetic papers are still available only in small quantities. A major obstacle to volume production is their relatively high cost—around \$1.50/lb. or more. With a specialty-paper market of around 2 billion lb./yr. to aim at, how-

ever, it's a sure bet that companies are going to devote an increasing amount of research to this field.

## New petrochemical processes will harness ultrahigh temperatures

Richfield Oil and MHD Research, Newport Beach, Calif., are cooperating in a joint research program to develop petrochemical processes built around plasma technology. Richfield is among the first of the oil and chemical companies to announce an interest in plasma arcs as a tool in chemical synthesis, but other firms such as Du Pont, Socony Mobil and Texaco are believed to have similar research programs under way.

Attractions of the plasma arc are high temperatures (up to 60,000 F.) and high enthalpies (up to 50,000 Btu./lb.), leading researchers to believe that they can substantially increase the rate of known reactions, promote those impossible to achieve in lower energy states.

Richfield will not identify the petrochemicals that it hopes to make in a plasma arc. Two possible reactions, however, are production of acetylene and carbon black. Thermal Dynamics Corp., Lebanon, N. H., has already published data on the making of these two products.

In a typical run to produce acetylene from kerosene, Thermal Dynamics obtained an off-gas containing 18.4%  $\text{C}_2\text{H}_2$  along with 27.2%  $\text{H}_2$  and 2.7%  $\text{CH}_4$ . Energy consumption was only 3.55 kw./lb. of acetylene.

Vitro Laboratories has also synthesized chemicals, using its Sheer-Korman arc (*Chem. Eng.*, Dec. 29, 1958, p. 24). It has produced high-energy fuels under Air Force contract, has come up with some developments in petrochemicals that have been taken over by a "large oil company" for further research.

## Hydrogen reduction of copper wins approval for full-scale plant

The hydrogen reduction process of metal making, which has had a stop-and-go career in North America, has been given the green light for a big \$23-million copper plant to be built in the Philippines. Prime contractor for the 14,000-ton/yr. plant is Foster Wheeler Corp.

# ACETATES:



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**Cu** Cupric Acetate, crystal; reagent and technical grades. Outstanding quality and highest purity . . . easy to handle. Reagent grade used in manufacture of synthetic fibers. Technical grade used in manufacture of dyes, coppered mirrors and printed circuits.

**Pb** Horne's Dry Lead\* (basic lead acetate) for clarification in sugar analysis. Saves time, increases accuracy and simplifies calculations. Officially adopted by Association of Agricultural Chemists and International Commission for Uniform Methods of Sugar Analysis. \*Reg. U.S. Pat. Off.

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Facility, to be built on Mindanao Island, will probably come on stream in late '62. Here is an outline of the proposed flowsheet: copper ore is subjected to ammonia leaching that dissolves the copper and zinc. Leach slurry flows through a countercurrent decanter that separates the gangue. Solution flows through an ammonia stripping step that removes and recycles excess ammonia to the leach stage.

The copper-zinc solution passes to a reactor where injected air oxidizes complex copper amines to make them suitable for reduction. Finally, the stream is pumped to the reduction autoclaves where hydrogen selectively reduces the copper, which precipitates as a fine powder, leaving the zinc in solution. In the new Philippine plant, the zinc will be either sold as zinc oxide or refined electrolytically, depending on market demand; 100,000 tons/yr. of ammonium sulfate will also be produced.

Copper powder will be compacted into solid strip and tubing via methods developed by E. W. Bliss Co. (*Chementator*, Oct. 6, 1958, p. 45). Powder production process was developed by Chemetals Corp., New York, in cooperation with Sheritt Gordon, which produces cobalt and nickel by hydrogen reduction at its Fort Saskatchewan, Can., plant.

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*The Air Force has decided to operate its own liquid oxygen plants at Atlas and Titan ICBM bases. This decision flies in the face of objections from private LOX producers that the Air Force would be competing unfairly with private industry. Eleven Atlas bases and five Titan installations are involved in the directive.*

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## Potpourri of new developments pours out of SPE meeting

Among the eye-catching achievements revealed at the Society of Plastics Engineers' recent annual meeting in Washington, D. C.:

- U.S. Naval Ordnance researchers at China Lake, Calif., see heat endured by polymers as a tool rather than a destructive force. They are working with materials whose degradation products will withstand 6,000 F.

Navy's approach involves synthesis of completely new intermediates and polymers—phenoxides and phenoxyaldehyde resins of titanium, zirconium, hafnium, tantalum and columbium. (Only titanium and zirconium phenoxides have ever been synthesized before.)

The new resins, when exposed to heat in rocket nozzles, form metallic carbides that are among the highest melting materials known. A system of 4 TaC + HfC, for example, melts at 7,619 F. Use of resins rather than the carbides as initial nozzle materials vastly simplifies fabrication, lowers cost of forming the components.

- Developers of a new variation on filament winding are imitating bamboo's filament structure. They find this multiplies the number of structural applications in which the strength and flexural benefits of filament winding can be exploited.

Products of the new bamboo-inspired filament windings have been dubbed "chain frame structures" by B. F. Goodrich Aviation Products, which recently acquired rights to the development. Weaving resin-impregnated reinforcing filaments into a series of interlocking loops forms structures that are 35% lighter, have better physical properties and cost less than similar pieces that are made of magnesium or aluminum.

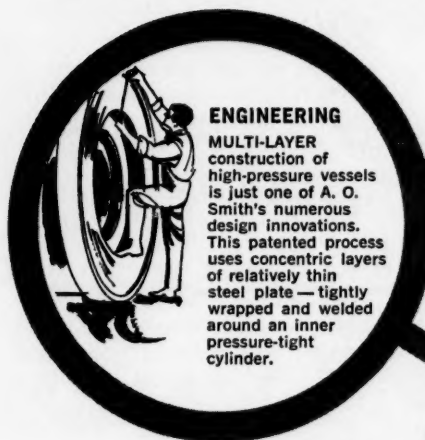
Chain frames take advantage of: (1) fiber reinforcement that is upgraded with increasing length of individual filaments, (2) unidirectional filament structures that have tensile and flexural strengths many times greater than random patterns. Practical application of chain frame structures may range from space platforms to frames for storage silos.

- First use of glass-reinforced plastics as a major structural component in jet-engine power plants was described by Westinghouse engineers. They have developed a glass-reinforced-polyester molded compressor housing for an aviation gas turbine that allows plastics to enter a field formerly the exclusive domain of metals.

- A new family of structural adhesives—epoxy-nylon resins—have been added to the select circle of materials qualifying for high-strength bonding applications in the aircraft and missile industry. Developed by Narmco Industries, the new products perform equally well in sandwich and metal-to-metal uses, while older adhesives are good for only one or the other.

*For More Industry News... p. 82*

# INTEGRATED specialization



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**MULTI-LAYER** construction of high-pressure vessels is just one of A. O. Smith's numerous design innovations. This patented process uses concentric layers of relatively thin steel plate — tightly wrapped and welded around an inner pressure-tight cylinder.



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# CE SAMPLES CPI CRYSTAL

Here are capsule versions of forecasts and year-end estimates by key men in key process industries. Some over-all trends for '61:

Excess capacity, low market prices and rising production costs will continue to plague industry.

SALES WILL GAIN,  
BUT LESS THAN USUAL.

"Further  
Tightening"

## PLASTICS

Executives currently wearing the rosiest-colored glasses are found in the plastics industry.

Prospering despite the general economic slowdown, plastics producers boast '60 sales of \$3.25 billion—an 8% gain over '59 figures—and say that '61 will be another record year. To quote Harry M. Zimmerman, head of Seiberling Rubber Co.'s Plastics Div.: "In '61, whether a recovery occurs in the spring or takes until summer . . . our industry should produce at least a 10% gain in volume over last year."

### Items:

• Today's automobiles carry 22 lb. of built-in plastics; the average

refrigerator, 18 lb.—while more and more boats are plastic from stem to stern. These areas are representative of the increasingly broad consumer markets that plastics are penetrating.

• Prices of most plastics continue to be slashed as high-volume production methods lead to lower manufacturing costs. On a weight basis, plastics have dropped an average 34.5% in price since '55—while steel, for example, now sells at a 20% higher price.

• Fastest-growing plastic is still polyethylene. With sales of 1.26 billion lb., it led the way again in '60, reports W. R. Grace & Co. In the blow-molded high-density polyethylene bottle market alone, 700 million units will be sold in

'61, claims Owens Illinois Glass, more than double the quantity sold in '60.

• In '60, polystyrene production grew 5%—enough to put it over the billion-lb./yr. mark, reports The Society of the Plastics Industry. The vinyls grew another 4%; polyethylene, 12%; and polyester, 8%. Over-all gain for the industry since '52: 177%.

## METALS

Everybody's cautious this year.

**Aluminum**—Mindful of their own wild-eyed forecasts this time last year (10-20% increases in demand were predicted, while a 7% decline developed), aluminum producers agree that a "near-record" demand is possible in '61—but that low market prices, rising production costs, and excess capacity will continue to harass the industry.

Lawrence Litchfield, Jr., president of Alcoa, notes that aluminum users' inventories have been depleted to rock bottom; so '61 should show a demand upsurge. Besides, new markets for aluminum are opening up: automobile engines (a '60 breakthrough), residential siding (300% market gain over the past five years), rigid containers (up 120% from Dec. '59), electrical (300% jump since '58).

Against all this, however, is last August's 11½¢/hr. wage boost—with another for 9¢/hr. slated for this August 1. D. A. Rhodes,



# BALL . . . .

Kaiser Aluminum & Chemical's president, speaks vaguely of "industry programs directed toward achieving lower costs in raw materials, production and . . . selling activities," but is just as cautious as Alcoa's Litchfield when it comes to predicting for '61.

**Stainless Steel**—Forecasts are pessimistic. Most stainless producers are certain, as are their aluminum-industry counterparts, that users' inventories have now reached a minimum level. However, they note, this is not to say that '61 will necessarily bring more than a token upswing in demand.

Quarter by quarter in '60, shipments of stainless declined; until by the end of the year, a total decrease of 6% was certain. Such producers as Republic Steel, Allegheny Ludlum, Armco, Jones & Laughlin and U. S. Steel are all predicting approximately the same total volume for '61 as was shown in '60: 578,000 tons.

The long-term view is more encouraging. Over the past 25 years, stainless production has boomed eight times as fast as that of total steel. By '67, predict the major producers, domestic stainless sales alone ought to top the 1-million-ton/yr. mark.

**Nickel**—The new year looks a little better to nickel producers. Henry S. Wingate, chairman of International Nickel Co. of Canada, Ltd., cites the 15% increase in nickel consumption during '60, predicts that before the end of '61, total free world nickel capacity will rise 20% to a record 600 million lb./yr.

**Ferroalloys**—"A moderate increase of about 5% in ferroalloy sales" is predicted for '61 by William H. Feathers, president of Union Carbide Metals. Since ferroalloy inventories are currently low in users' plants, he notes, the pattern is expected to be: buy more, use about the same, stock the rest.

**Magnesium**—Contrary to the

general trend in other nonferrous metals, magnesium consumption in '60 was up 12% over '59. But still, capacity lies idle; some plants (for instance Dow Chemical's Velasco, Tex., facility) are shut down.

Effects of the '57 stretchout policy in military aircraft production are still being felt; new uses for magnesium in missiles have yet to compensate for the volume loss. But upswings in export sales, and shipments to alloyers, are expected to continue; so forecasts are mixed, though generally optimistic.

## PETROLEUM

It'll be a good year for the petroleum industry, predicts Texaco's chairman Augustus C. Long. Domestic demand for petroleum and its products in '61, he estimates, ought to rise 2 or 3%; foreign demand, 7%.

This is almost a carbon copy of '60 performance, which represented a disappointing gain in domestic demand for petroleum products of only 2.1%—as compared with a 4% increase during '59. Still, '60 was a "good year," too.

Estimates of '61 performance in specific breakdown areas of the total industry haven't been attempted, but some statistics just in for '60 report:

- LPG sales chalked up a 10% gain over '59 record figures, indicates Phillips Petroleum for the industry.

- Natural gas sales soared in '60—8% higher than '59 levels.

- Gasoline demand was disappointing, however. The American Petroleum Institute indicates that '60 consumption ran only 2% higher than the '59 figure. Compact cars, apparently.

- Distillate fuel for home and industrial use was consumed at a level 2.8% higher than in '59, but residual fuel oil demand was 1.6% lower.

On the supply side of the pic-

ture, domestic crude oil production for '60 was about 1% below that of '59. Natural gas liquids production, however, increased by 7%, bringing total domestic production of liquid hydrocarbons to 2.9 billion bbl., a gain of 17 million bbl. over '59.

Industry verdict: slight upward trend in '61, but probably a percentage gain not much higher than that of '60.

## RUBBER

Worldwide rubber consumption is expected to hit a new high in '61—but just barely.

J. W. Keener, president of B. F. Goodrich, predicts a 1% increase (to 3.8 million long tons) in world rubber use, exclusive of Iron Curtain synthetic rubber—but, he says, domestic rubber consumption will probably hold at '60 levels (1.6 million long tons).

On the other hand, U. S. Rubber's president George R. Vila predicts a hike of 2.5% in domestic consumption. It will be sales, he says, that hold fast (\$6.2 billion in '60).

Both companies, however, agree that '61 will see synthetic rubber grab around 71% of the domestic market on a tonnage basis.

As for the trend to compact cars—with their smaller tires—rubber industry spokesmen aren't worried. While tires will be smaller, there will be more cars on the road in '61 than ever before. If anything, look for rubber sales to mount.

## PAPER AND PAPERBOARD

Surplus capacity in the paper and paperboard industry will worsen in '61, predicts the annual capacity survey of American Paper and Pulp Assn. and National Paperboard Assn.

The associations expect a capacity increase of 4.2% in '61, but a gain in production of only 1.5%. Broadening the gap between production and capacity means a drop in operating rates, which have a close relation to profits. In '60, paper industry operated at 92.6% of capacity; paperboard, at 89%.—FA



# WHO'LL WIN THE TOP CHE AWARD IN 1961?



*You can influence the choice.*

*Take time now to send us*

*your nomination for the*

**15th Kirkpatrick Award  
for Chemical Engineering Achievement.**

Nominations are now open for the 15th biennial Kirkpatrick Award for Chemical Engineering Achievement, sponsored by this magazine. And you, the reader, may nominate your own candidate for this coveted prize. Here is what to do:

- Determine to your own satisfaction which company has done the most in the last two years to advance the practice of chemical engineering in industry, and to utilize its chemical engineers most widely in technical, professional and executive responsibilities.

- Then, prepare an unillustrated brief of no more than 500 words to support your choice. Mail this before April 15 to:

Cecil H. Chilton, Secretary  
Kirkpatrick Award Committee  
Room 2400  
330 West 42nd St.  
New York 36, N. Y.

- **Rewarding Group Effort**—Your efforts in submitting a well-chosen nomination will lead next November to recognition of some company, and its outstanding group of chemical engineers, for the most meritorious contribution to the advance of the industry and the profession during 1959-60. Note that this award recognizes the contribution of group effort rather than individual achievement.

The 1961 Kirkpatrick Award will recognize industrial developments that have reached commercial fruition, or have become

known publicly, since January '59. This year, for the first time, there will be honorable mention for four other companies, in addition to the winner. Therefore, in presenting your 500-word nomination, please:

- Describe the nature of the achievement.

- Define the period of its commercial fruition.

- Explain to what extent chemical engineers participated in its development.

- **Picking the Winner**—After the close of the nominating period, the secretary of the award committee will submit copies of each eligible nomination to each of the senior chemical engineering educators comprising the Committee of Award. These men head the 99 chemical engineering departments in U. S. colleges and universities accredited by the American Institute of Chemical Engineers and Engineers' Council for Professional Development.

Each committee member will study the briefs, and vote for the five best nominees, without establishing any order of rank among them. The finalists will then be asked to prepare detailed information, expanding on the three main points listed above. These presentations will include any supplemental records, data, articles or references that highlight the achievement, as well as the teamwork between the chemical engineering group and man-

agement, research, production and sales divisions of the company.

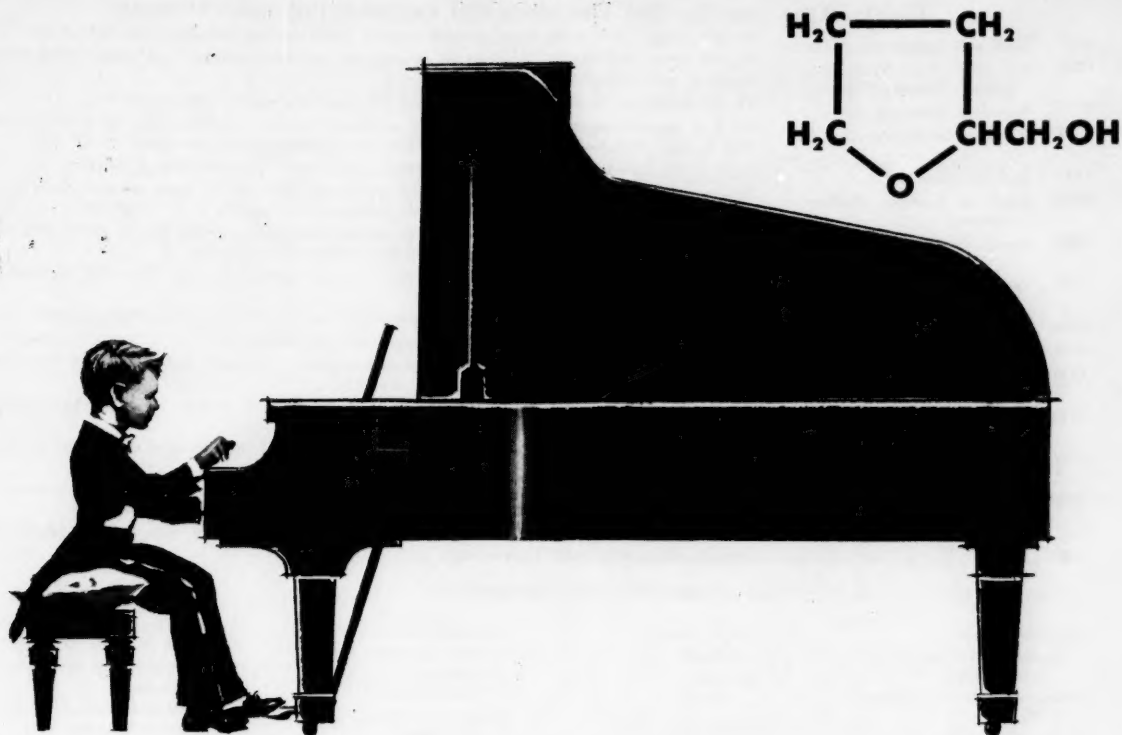
On July 15, the presentations will be submitted to a nine-man board of judges for final selection of the winner. Judges will be chosen from the larger Committee of Award and will act for it in the final selection. Announcement of the winner will be made in our October 6 issue.

- **The Prize**—The winner will be recognized by being presented with an appropriate bronze plaque that indicates the nature of the achievement. Plaque will be presented, on behalf of *Chemical Engineering*, at a formal dinner in New York's Hotel Astor on November 28. This event is an outstanding feature of the week-long activities that will center around the "Chem Show," the 28th Exposition of the Chemical Industries in New York's Coliseum. The other four finalists will share the recognition at the dinner with Honorable Mention citations.

- **Supporting Cast**—As in years past, S. D. Kirkpatrick, recently retired editorial director of *Chemical Engineering*, will preside as toastmaster. Also present will be members of the Committee of Award; representatives of past winners, of many chemical process, engineering and equipment firms, and of McGraw-Hill Publishing Co.

While *CE* readers will be the prime source of nominations for the Kirkpatrick Award, nominating briefs will also be accepted directly from eligible companies. Therefore, individuals who wish to suggest nominations but do not have adequate information for preparing the 500-word briefs may submit such suggestions directly to the companies involved. Or the committee secretary will serve as a clearing house for your suggestions, forwarding them to the proper people in the various companies.

For the honor roll of previous recipients of this award in years past, see the list that follows. You will note that in three instances awards went to industry groups: American Synthetic Rubber Industry (1943), Atomic Bomb Project (1946), Contributors to Extractive Metallurgy of the Atomic Age (1957).



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## These firms top the list for chemical engineering achievements

1933	Carbide & Carbon Chemicals Co.	For producing commercially many synthetic organic chemicals from petroleum and natural gas.
1935	E. I. du Pont de Nemours & Co. Organic Chemicals Dept.	For the successful industrial development of neoprene, synthetic camphor and certain other important chemicals and dyestuffs.
1937	Monsanto Chemical Co.	For developing the large-scale production and utilization of elemental phosphorus.
1939	Standard Oil Development Co.	For new chemical engineering processes and equipment to make available super-fuels for aviation, as well as other valuable products synthesized from the hydrocarbons of petroleum.
1941	Dow Chemical Co.	For recovery from seawater of magnesium metal, sorely needed for aircraft and munitions.
1943	American Synthetic Rubber Industry	For crowding into 24 months a project that in normal times would have required many years—a miracle of chemical engineering planning and construction. Awarded to 67 companies.
1946	Atomic Bomb Project	For contributing so significantly to the research and engineering responsible for this war-ending achievement. Awarded to 122 companies, universities and research organizations.
1947	Merck & Co.	For successful pioneering in the large-scale production of streptomycin and other vital medicinals and, in a broader sense, for service to humanity.
1948	Shell Development Co.	For the successful synthesis of glycerine from petroleum, for the first time, on a commercial scale.
1949	Celanese Corp. of America	For the outstanding chemical engineering integration of its textile, plastics and chemical operations.
1951	Phillips Petroleum Co.	For pioneering development of high-abrasion carbon blacks, and major contributions to the success of cold rubber.
1953	Carbide & Carbon Chemicals Co.	For the first commercial production of certain aromatic chemicals directly from coal by high-pressure catalytic hydrogenation.
1955	Dow Corning Corp.	For the participation of its chemical engineers in all phases of the successful commercial development of silicone products.
1957	Contributors to Extractive Metallurgy of Atomic Age Metals.	For research, development and application of chemical engineering principles and processing in the recovery of metals. Awarded to 77 companies, research and engineering organizations.
1959	Texaco, Inc.	For development and commercialization of a process to generate low-cost, pure synthesis gas (hydrogen) from liquid, gas or solid hydrocarbons.

## 1961 committee of award

Agricultural and Mechanical College of Texas J. D. Lindsay	University of Florida W. H. Beisler	University of Minnesota N. R. Amundson	Rice University W. W. Akers
Alabama Polytechnic Institute C. A. Basore	Georgia Institute of Technology H. V. Grubb	University of Mississippi F. A. Anderson	University of Rochester S. A. Miller
University of Alabama K. W. Coons	University of Houston C. V. Kirkpatrick	University of Missouri G. H. Beyer	Rose Polytechnic Institute J. N. Reeds
University of Arkansas C. W. Oxford	University of Idaho M. L. Jackson	Montana State College Lloyd Berg	School of Mines and Metallurgy Dudley Thompson
Bucknell University H. D. Sims	Illinois Institute of Technology R. E. Peck	University of Nebraska J. H. Weber	University of South Carolina B. L. Baker
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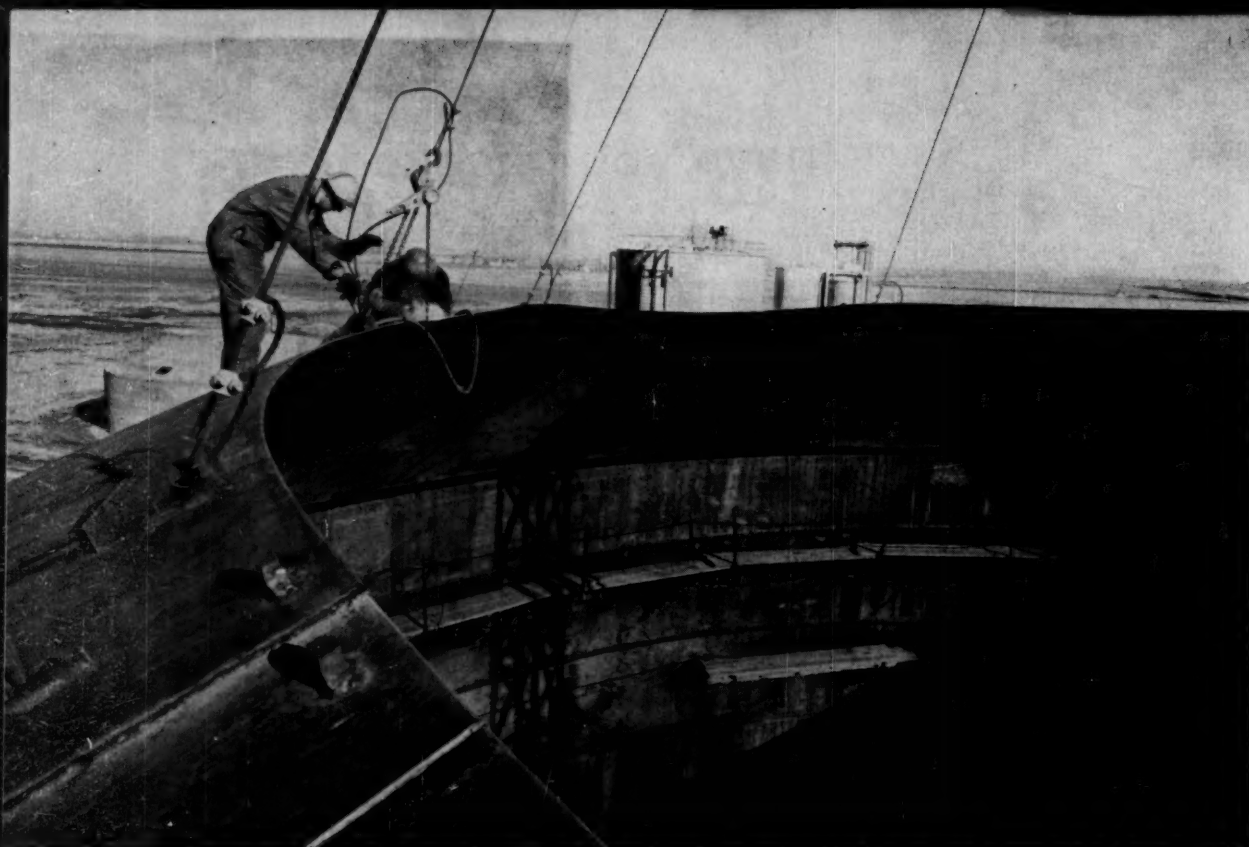
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Welders hurry to complete U.S.I.'s 7,000-ton  $\text{NH}_3$  storage tank at Tuscola, Ill. Other producers rush facilities, too.

## SWING TO COLD $\text{NH}_3$ SAVES STORAGE \$\$

*Producers suddenly realize advantages of low-pressure tanks, rush new facilities to meet anticipated spring demand for fertilizer.*

To cope with the short-time-peak demand for fertilizer, anhydrous ammonia producers are making radical changes in their handling and storage methods—from full-pressure, uninsulated vessels, to atmospheric pressure in heavily insulated ones.

Behind this move are several big economic advantages:

- Reduction in capital investment approaching 50%.
- Use of smaller production units, which can be operated over longer periods of time.
- Increase in capacity of individual units.

► **Six Recent Installations** — The method is similar to techniques employed for propane (*Chem. Eng.*, Mar. 23, '59, p. 11) and chlorine

(*Chem. Eng.*, Apr. 6, '59, p. 76). It maintains the anhydrous ammonia in a liquid state at  $-28^\circ\text{F}$ . by surface evaporation of the product.

The technique has been employed to a limited extent for ammonia, both here and in Europe, for a number of years. First U.S. installation, by Southern Nitrogen, Savannah, Ga., was a 7,500-ton tank in 1956. In 1959, two additional installations were made—St. Paul Ammonia Products, St. Paul, 12,000 tons, and Cooperative Farm Chemicals Assn., Lawrence, Kan., 15,000 tons.

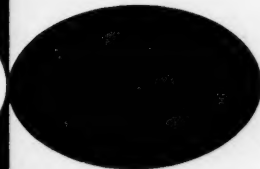
However, the big swing came within the last few months. Leading size-wise is Phillips Chemical Co. with atmospheric storage facili-

ties totaling 60,000 tons—two 15,000-ton tanks at its Cactus ammonia plant near Etter, Tex., two at its East St. Louis, Ill., terminal.

Others include Mid-South Chemical, 9,500 tons of storage capacity at Memphis, Hooker Chemical, 3,300 tons at Tacoma, Wash., and U. S. Industrial Chemical, 7,000 tons at Tuscola, Ill.

In addition to the above mentioned atmospheric storage facilities, Phillips has three 150,000 bbl. tanks at its Adams terminal, one 325,000 bbl. tank at Cactus, for off-season storage of ammonia by dissolving it in water. The water can hold about 42% ammonia in winter, 35% in summer, with 1-2 in. water pressure. Total capacity is 25,000 tons of ammonia.

When demand picks up in the spring, solution is pumped from the tanks through two fractionating columns operated in parallel. Capacity of the two columns is 350



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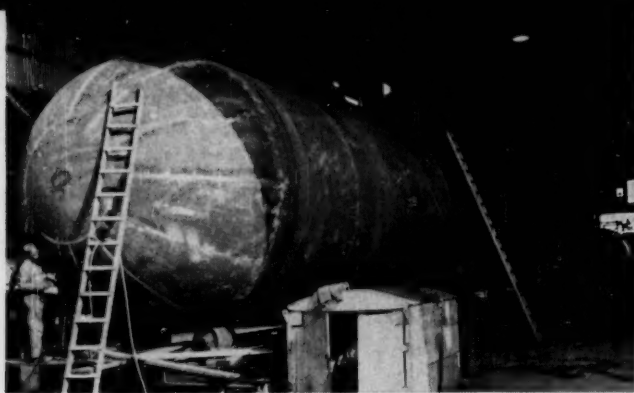
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Tanks, mounted in saddles on barges, heavily insulated and refrigerated, will transport anhydrous  $\text{NH}_3$  from Phillips' Etter, Tex., plant to East St. Louis, Ill., terminal.



tons anhydrous ammonia/day. Still bottoms are recycled to storage tanks for reuse.

► **Atmospheric Barges, Too** — To transport the anhydrous ammonia from Etter to East St. Louis, Phillips last fall contracted with Avondale Shipyards, Inc., New Orleans (*Chem. Eng.*, Dec. 12, '60, p. 198), for construction of two refrigerated barges, capacity 1,700 tons of anhydrous ammonia. Barges may also be used for propane.

Barges are to be open-hopper design with two heavily insulated tanks on each. Designed to be handled independently, or as an integrated tow, the lead barge will measure 305 x 44 x 12½-ft., the trailing one, 284 x 44 x 12½-ft.

Tanks are 16-ft. O.D. x 242½-ft. O.A. They are constructed of special ½-in. low temperature steel with ½-in. thick hemispherical heads. Refrigeration equipment on each barge will maintain the ammonia at -28 F.

► **New Look In Tanks** — For many years ammonia plants and terminals were characterized by 30,000-gal. horizontal tanks and/or pressure spheres. The new tanks

look more like those used for storage of oil. They are large-diameter vertical cylinders, with flat bottoms and conical tops — Mid-South's 9,500-ton tank is 106-ft. in dia., 70-ft. tall, and U.S.I.'s 7,000-ton one has an inner tank that's 88-ft. in dia. x 56-ft. high.

The new tanks can't stand much pressure. But it isn't necessary, since their large volume effectively dampens sudden fluctuations that could cause pressure to build up or decrease in small vessels.

Tanks are heavily insulated to minimize heat flux. Girdler, who is building the Phillips facilities, uses several inches of Styrofoam board, covered with a corrugated aluminum jacket. Top is covered with a built-up asphalt roof. Chicago Bridge & Iron Co., builders of Mid-South and U.S.I.'s units, fabricates an outer tank, fills the 30-in. space between it and the inner tank with perlite insulation. This double-wall system creates an absolute vapor barrier.

► **Refrigeration Needed** — Tanks are equipped with refrigeration systems to compress the ammonia that evaporates within them, and

to cool the product when it is received in barges or tank cars at high pressures.

To provide flexibility, and permit maintenance during operations, refrigeration system usually comprises two or more compressors, each with a capacity equal to the load resulting from evaporation from the storage tank.

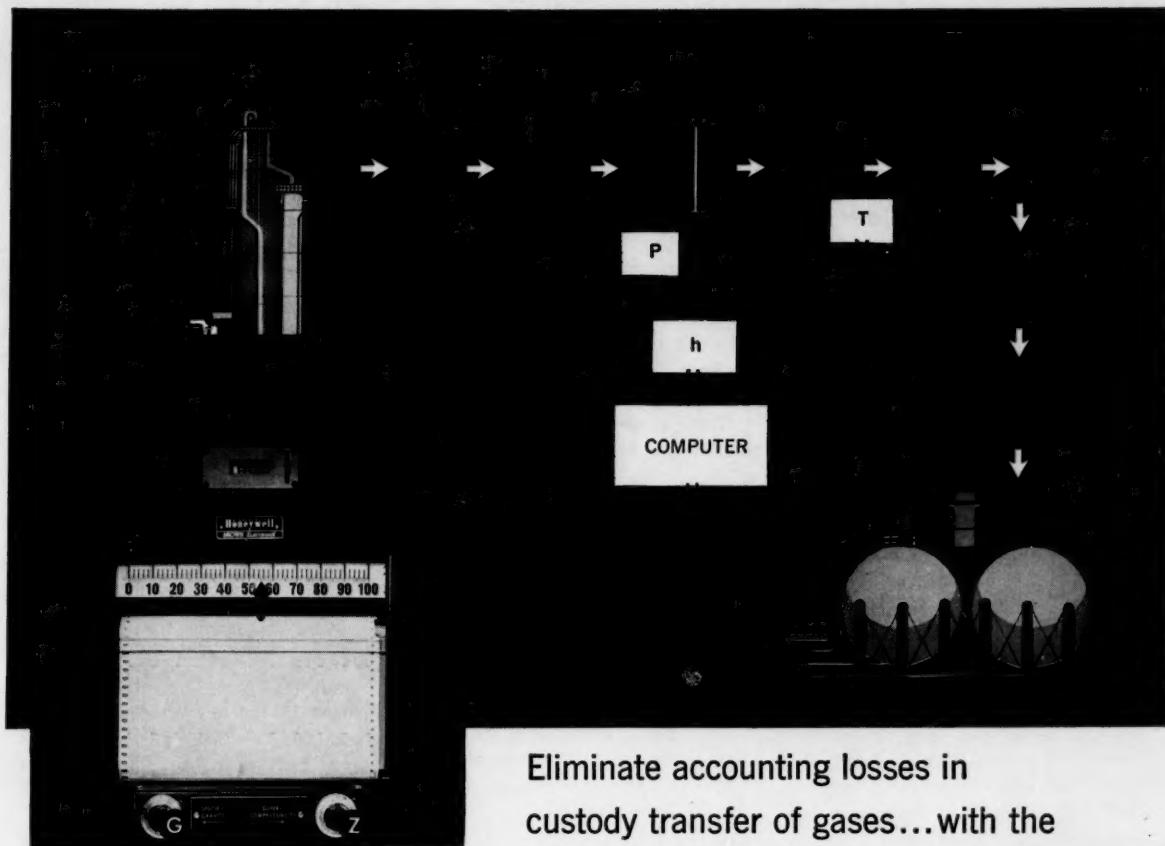
In addition, a standby generator is usually provided. It should have sufficient capacity to operate one compressor, the foundation heaters, and the control system. This will prevent venting of the product in case of a plant-power failure.

Ammonia from tank cars or barges goes to a flash drum and intercooler where pressure is reduced to atmospheric and temperature to -28 F. Then it enters storage tank. Ammonia evaporated in the flash drum, as well as that from the storage tank, is compressed, routed through a purge system to remove noncondensables, then cooled and discharged into the tank. When there is some other use for the ammonia, the gases can be discharged directly to tanks of water (to make aqua ammonia), or to nitric acid for production of ammonium nitrate.

To unload ammonia from the storage tanks, the liquid is simply passed through a heater, raising its temperature to about 32 F. to protect the steel in tank cars or trucks.

In case it is to be removed at a high rate, means should be provided for preventing vacuum in the tank. A vacuum relief valve is supplied for emergencies. To prevent loss of gas, however, a small line from the outgoing heated stream to the flash tank, and another line from the flash tank vapor space to the storage tank vapor space will supply necessary vapor to compensate for the liquid removed. A controller operating between 0 and 0.2 psig. will open and close valves in these lines as needed.

To provide for possible failure in this volume-replacement system, a shut-off valve controlled by storage tank pressure should be placed in the discharge line, and set to close at a vacuum of 0.1 psig.—AVG



Here's how the Honeywell gas flow computer solves a gas flow equation:

$$Q = K \sqrt{\frac{hP}{TGZ}}$$

Where **Q** = mass rate of flow, scfh  
**h** = differential pressure, inches of water  
**P** = static pressure, psia  
**T** = flowing temperature, °R, (°F + 460)  
**G** = specific gravity  
**Z** = super-compressibility  
**K** = orifice flow constant

The *ElectriK Tel-O-Set*  $\Delta P/I$  transmitter measures **h**; an absolute pressure transducer measures **P**; and a resistance thermometer bulb measures **T**. The analog computer multiplies **h** by **P** and divides by **T**... and sends a resultant millivoltage to the *ElectriK* recorder. The recorder applies the correction factors **G** and **Z**, extracts the square root, and records the resultant mass flow **Q**.

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## COAL CHEMICALS: ON THE WANE

*Research aimed at making coal a source of synthetic organics is dying out both in Europe and the U. S.*

Despite a brief revival of interest in coal as a source of "petrochemicals" during 1960 (*Chem. Eng.*, Apr. 18, 1960, pp. 156-159) the plans of Philadelphia & Reading and Glen Alden Coal have apparently been shelved. And CE's bureaus in London and Bonn report that interest in coal as a source of chemical building blocks is fast waning in Europe also. The only synthesis area where coal is holding its own is in the production of town gas, where the Lurgi gasifier has been able to achieve competitive costs in certain parts of England and Germany. But although some industry men believe that rising oil and natural gas prices will make coal competitive again in the U.S. by '70, the short-term outlook for coal-synthesized chemicals can only be described as bleak.

In Britain, two new gas plants are using Lurgi coal gasifiers: one at Westfield, Scotland, has gone on stream, will be producing 30 million cu. ft./day by '62 when the second, at Coleshill, Warwickshire, will swing into operation. England's Gas Council believes that the net cost of this town gas, including enrichment to standard calorific value (with LPG), will be under the breakeven point of 12¢/100,000 Btu.

Two other gasifier designs are being developed by the Gas Council: one is a high-pressure, fixed-bed slagging gasifier that offers greater throughputs and feed flexibility than the standard Lurgi unit. The second is an Otto-Rummel double-shaft gasifier that operates on air and uses slag as the heat transfer medium. It will take at least five years, however, before either of these designs could become commercial.

In other parts of hydrocarbon-deficient England, the outlook for coal synthesis is not bright. Although the bulk of England's acetylene, benzene and phenol still comes from coal, the trend is toward the

use of imported oil. The venerable Fischer-Tropsch process to make oil from coal has finally been pronounced uneconomic by the Ministry of Power, and research is being discontinued.

Even in Germany, the home of much coal-chemical technology, all of the old coal hydrogenation plants have switched to petroleum residuum and will probably shut down soon because diesel oil and gasoline can be produced more economically from imported oil. The only coal-originated gasoline and diesel oil now sold in Germany is manufactured in prewar East German plants, using low-grade brown coal. These units will probably shut down by '65 when the big crude-oil pipeline from Russia will be completed.

## Magnetic Stirrer Can Not Leak: It Has No Seal

Mixing under pressure or high vacuum, which may require elaborate shaft seals to eliminate leakage or product contamination, may be simplified with the development of a stirrer that requires no openings to the outside atmosphere for rotating parts.

Invented by Leon Levi, New York, the stirrer is patterned on the same principle as his laboratory unit that has been on the market for some time. Both units transmit flux from a stator to a rotor through a solid material—glass or stainless steel—so that once installed over a vessel opening, there is no shaft seal needed to protect against leakage.

Basically, the device consists of a stator surrounding a stainless steel cylinder through which the rotor extends. The low-friction rotor does not touch the cylinder walls, is supported on Teflon bearings. If motor and stirrer speed

are the same, rotor is extended downward to be the stirrer shaft. If speed reduction is required to  $\frac{1}{2}$  or  $\frac{1}{4}$  of motor speed (3,600 rpm.), a cupola is placed over the unit with the geared-down stirrer shaft extending down through the rotor. Cooling coils are provided to prolong the life of the electrical components.

## First U.S. Offering of Chlorinated Polypropylene

A new film-forming resin, made by chlorinating polypropylene to a minimum level of 65%, is being made commercially for the first time in the U.S. by Hercules Powder Co., Wilmington. Called Parlon P, the new product appears equal to Hercules' Parlon (chlorinated natural rubber) in chemical resistance and has better heat and light stability.

Parlon P is a white, free-flowing powder that is soluble in many common solvents except alcohols or aliphatic hydrocarbons. Slightly cheaper than Parlon, its commercial uses are in protective coatings, inks, adhesives and flame-retardant compounds.

In coatings, it contributes hardness, abrasion resistance and resistance to alkalis, acids, salt sprays, moisture, mold growth, heat and sunlight deterioration. Its alkali resistance and good ultraviolet resistance suggest application in barrier coats for freshly poured concrete and in nondiscoloring clear sealers for coating masonry.

Producing clear, water-white films, the new polymer has good solution color. Its color and film clarity indicate use in overprint varnishes and in vehicles where clear whites and pastels are wanted. Heat and light stability may be enhanced with the addition of up to 3% of an epoxy-type stabilizer.

Parlon P is currently being made in the same facilities as Parlon, although the process reportedly is different.



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## HOW'S BUSINESS IN CRYOGENICS?

*A lot has been published about cryogenics technology, but not much on the question: What does cryogenics look like—present and future—as a business proposition?*

*Recorded below, CE interviews three men, with key posts in Linde's new Cryogenic Products Dept., whose business it is to have the answer.*

**EDITOR:** How do you define the cryogenics business? For example, how do you distinguish it from that of industrial gases?

**MURRAY:** The dividing line between cryogenics and refrigerators is somewhat arbitrary. Linde sets it at  $-150^{\circ}\text{F}$ .—that is, cryogenic products are those liquefied gases whose boiling point is below  $-150^{\circ}\text{F}$ .<sup>\*</sup> Those gases, then, come under the charter of Linde's new Cryogenic Products Dept. if they are to be not only bought, shipped and stored but also used as liquids.

**HUFFARD:** The fluids themselves are liquefied industrial gases; liquid nitrogen, oxygen, hydrogen, argon, helium, neon, xenon and krypton. The distinction is in the markets: the biggest markets in the industrial gas business today are the steel industry and the chemical industry. The biggest market for the cryogenics business today is in missiles—for defense and space research.

<sup>\*</sup>Air Products sets it at  $-250^{\circ}\text{F}$ .

**MURRAY:** Some years from now, we hope that the other growing cryogenic markets—in the food industry, in biology, in electronics—will approach or surpass the size of the missile and space industry market.

**EDITOR:** How big are current markets for cryogenic fluids?

**MCCANDLESS:** About 1,000 tons/day of oxygen used as liquid are sold by the industry. In addition, there are another 1,000 tons/day produced on site for missiles. So there are 2,000 tons/day of liquid oxygen used for cryogenic purposes, and that almost entirely in the missile business.

**EDITOR:** And what would be the corresponding tonnage figure for nitrogen?

**HUFFARD:** About 400 tons/day, of which 75% goes to missiles—one half of it for pressurizing liquid oxygen, the other for cold-testing components that are going to come in contact with liquid oxygen. The rest goes into freezing

bovine semen used for artificial insemination of dairy cattle and into the cooling of infrared detectors.

Total sales per day of cryogenic nitrogen, which is just a little more expensive than liquid oxygen, are about \$30,000. This is about \$10 million/yr.

**MURRAY:** Sales of cryogenic oxygen are perhaps three times that much. Mac, make your point here about the mills to megabucks. Now we're talking about dollars in this business.

**MCCANDLESS:** Well, I noticed last night, when we were going through some of these numbers, how easy it is to get confused because the products we sell probably have a wider price spread than in any industry you will ever run into. To give you examples, the cheapest product we sell is oxygen in large tonnage quantities as a gas (blast furnace oxygen, which is  $\frac{1}{2}\text{¢/lb.}$ ). The most expensive product is xenon; it doesn't make any difference whether it's liquid or gas. It sells for \$30/liter of gas, which is probably \$3 million/lb.

**EDITOR:** Got any serious bidders for this?

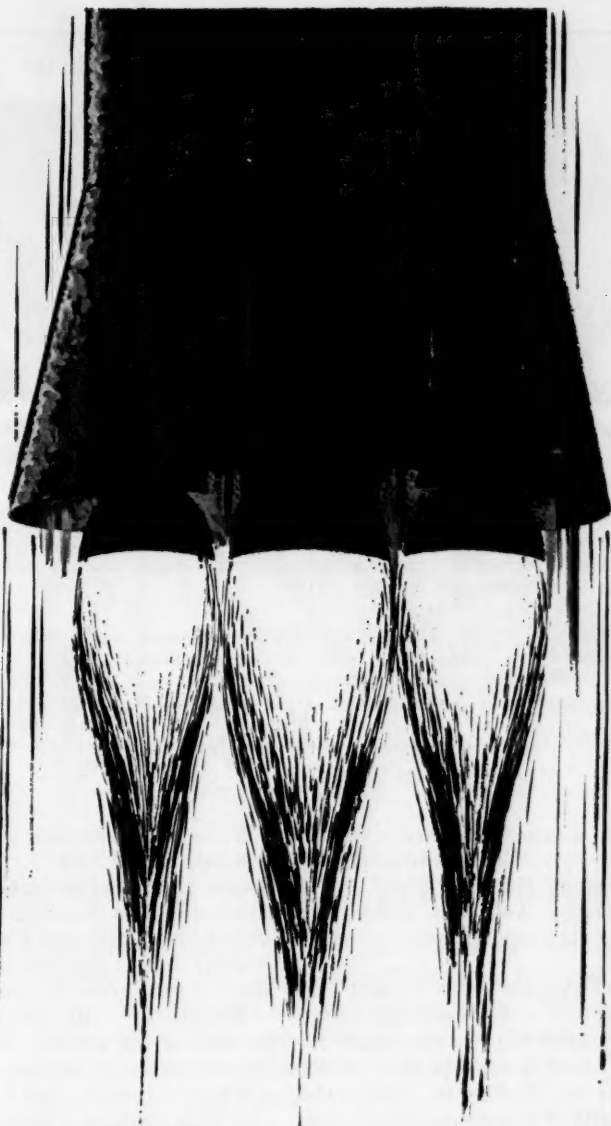
**MURRAY:** We've sold a little, for use as liquid in a bubble chamber. A parallel for the price spread is that we're working from  $-150^{\circ}\text{F}$ . down to only a few degrees above absolute zero. Having put the first commercial liquid hydrogen plant on stream on the West Coast a few months ago, we're really working with tonnage liquid hydrogen, which is down toward absolute zero.

**MCCANDLESS:** Air Products built a 30-ton/day plant for the Air Force for liquid hydrogen in Florida. This is a government-owned

**Today's big cryogenic use: missiles;  
tomorrow: food, biology, electronics**

Cryogenic Fluids	B. P. ( $^{\circ}\text{F}$ )	Approx. Cryogenic Usage (Tons/Day)
Liquid oxygen	-297.3	2,000
Liquid nitrogen	-320.5	400
Liquid hydrogen	-423.0	40
Liquid helium	-452.1	*
Liquid argon	-302.6	*
Liquid neon	-410.7	*
Liquid xenon	-163.0	*
Liquid krypton	-244.0	*

<sup>\*</sup>Present cryogenic usage is negligible.



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## Fielding questions on cryogenic markets:



Glenn A. Murray,  
Manager



E. L. McCandless,  
Assoc. Tech. Director



P. P. Huffard, Jr.,  
Sales Manager

Our panel consists of these three key men in Linde Co.'s newly-formed Cryogenic Products Dept. Though a pioneer in the cryogenics field, Linde timed formation of a department completely devoted to cryogenic activities to coincide with findings that:

- A significant percentage of the company's business is cryogenic.
- Field has a large growth factor needing specialized attention.
- Use of cryogenic fluids and equipment in the food, biology and electronics industries is about to kick off in sizable volume.

plant. Linde is the first company to go into liquid hydrogen on a commercial basis.

**EDITOR:** And that makes two liquid hydrogen plants in existence?

**MCCANDLESS:** No. There are about four or five small plants built and operated by various people for the Air Force; then there is the large one in Florida. Their total capacity is something like 42 tons/day. Ours is the only privately owned tonnage liquid hydrogen plant. It has a capacity of 6 tons/day, at Torrance, Calif.

**MURRAY:** Hydrogen is extremely important to the rocket and missile activity and to space activity. It is one of the best fuels for a chemical rocket and one of the best fluids for use in a nuclear rocket.

**EDITOR:** How much liquid hydrogen is being used today?

**MURRAY:** I guess there isn't a great deal used out of the government plant today. But the trend seems to be that we're going to have privately operated or industry operated plants from here on in.

National Aeronautics and Space Administration (NASA) has just awarded a contract under which Linde will build its second privately owned liquid hydrogen plant, a 26-ton/day unit at Fontana, Calif. It's due for completion in June '62.

**HUFFARD:** So this will give you an idea of the growth; in July of '60, we turned on a plant that has six tons of capacity and in June of '62, we'll start up a plant with 26 ton/day capacity. Fourfold growth in two years.

**EDITOR:** I'd like to have your guess as to the size of the liquid hydrogen market in '65 or '70. And will it all be government use?

**MCCANDLESS:** I wouldn't be surprised if by '65 it would be on the order of 100 tons/day, not necessarily all for government use. You saw in the newspaper recently that Bell Telephone Laboratories had made a serious proposal that it set up a network of communications satellites for commercial worldwide telephone communication.

**EDITOR:** When did the various markets for cryogenic fluids be-

gin to take shape and how fast did they grow?

**MURRAY:** The rocket and missile business started getting big, in terms of tonnages, in '53 or '54 and is tremendously so today.

I'd say that the use of liquid nitrogen in the food business became of significant interest only a year or two ago.

The use of liquid nitrogen in the cryobiology field became significant in '59. Although we started research on the freeze preservation of bovine semen for artificial insemination of dairy cattle in '49, the market just became significant in '59.

Some liquid nitrogen is used in chemical processing for cooling during production of other cryogenic fluids but such use is, of course, largely captive. Uses such as scrubbing of hydrogen feed gas for ammonia manufacture are not truly cryogenic by our definition. The nitrogen gas is liquefied right in the scrubber itself.

Then, electronics. The cryoelectric field started becoming a commercial factor about ten years ago. Are you acquainted with what cryogenics means to electronics?

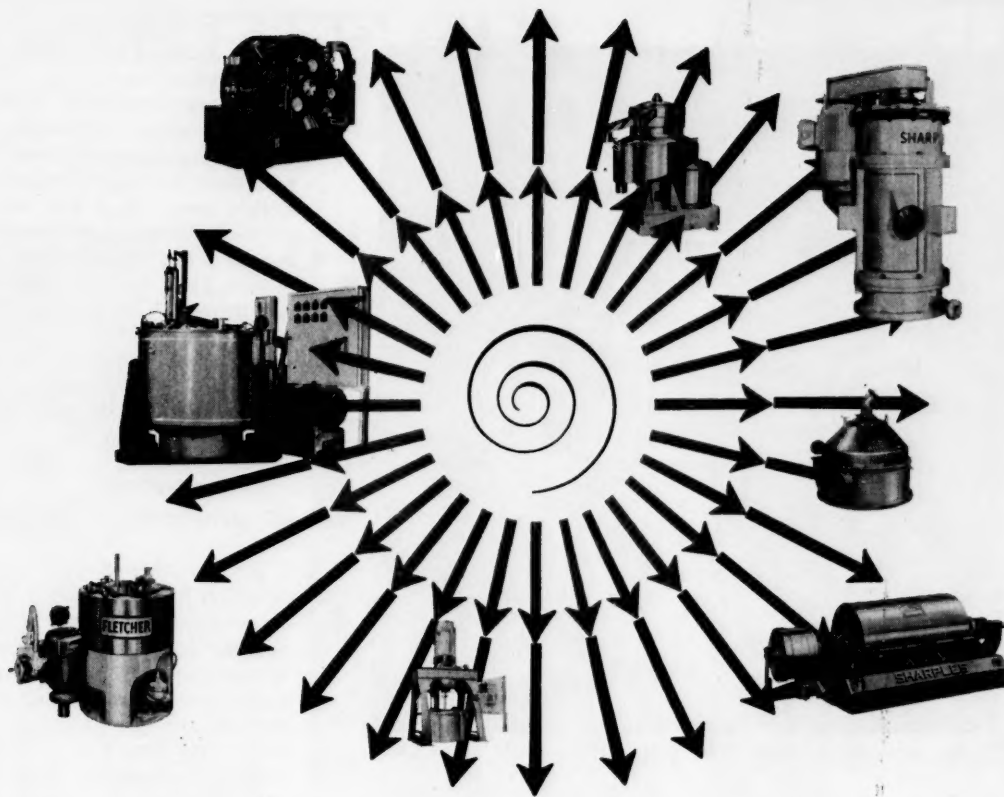
**EDITOR:** The cold temperatures completely change the characteristics of metals and other materials, don't they?

**MURRAY:** Particularly their electrical resistance. When electronic components can work at temperatures in the liquid helium range, engineers can take a room-size computer and shrink it down to shoe box size.

**MCCANDLESS:** In the electronics field, there are two main cryogenics applications: one is the use of liquid nitrogen to cool infrared detection cells; the other, using liquid helium to achieve superconductivity in metals, to do tricks such as Mr. Murray mentioned. These uses are small and widespread. They don't total very much today, but it looks as if they will in the next few years.

**EDITOR:** Are these superconductivity devices commercial yet?

**MCCANDLESS:** No, I'd say they're all in the experimental state, and yet, on a very broad scale. There's a lot of experimenting going on in



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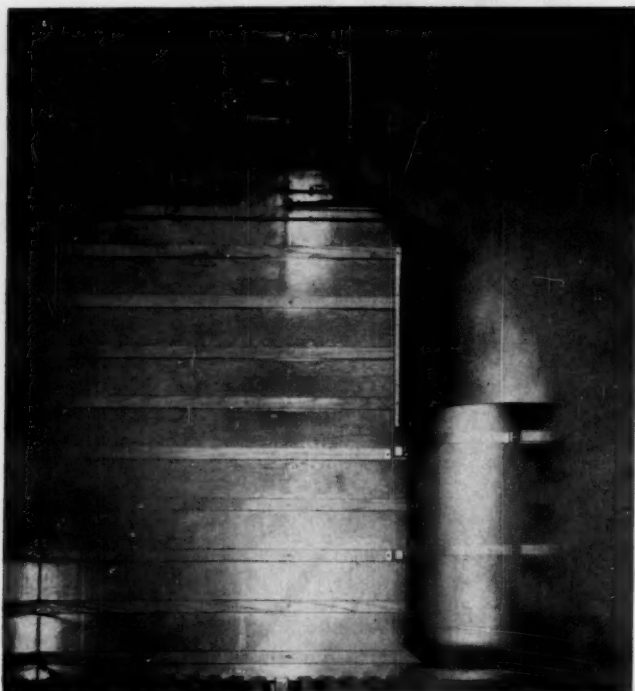
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Liquid nitrogen, sprayed from vessel, right, cools food truck.

every major U.S. electronic company.

**EDITOR:** About how big is the market for helium?

**MCCANDLESS:** This is a market that, at the present time, is filled mostly by each laboratory having its own cryostat, a generator of liquid helium temperatures. And there are about 150 or 200 laboratories in the U.S. equipped to generate liquid helium.

There is very little liquid helium sold today. We sell it from our Tonawanda laboratory in 25-l. containers. The Bureau of Standards at Boulder, Colo., has a liquid helium plant and they ship 25- or 50-l. containers once in a while. Lockheed on the West Coast ships a little bit to electronic companies in the San Francisco Bay area, within a 50 mi. radius.

Evaporation losses make shipping economically prohibitive with the liquid helium containers that are available. If helium is shipped in a container that in hydrogen service would give a loss of, say, 1%/day, helium loss might be 10%/

day. And we're talking about \$12 or \$15/liter. A four-wall, nitrogen-shielded container keeps losses down and has been used on sort of a laboratory scale, but it's too fragile.

Now we're bringing out a liquid helium container that we hope will change all this—a nice, clean cylinder, 4 ft. high, with essentially one container on the inside wrapped in superinsulation. A 25-gal. container will lose only 1½%/day.

**EDITOR:** What do you mean by superinsulation?

**HUFFARD:** Linde's SI insulation, which consists of alternate layers of aluminum foil and glass cloth, very thin—1-mil thick.

**MCCANDLESS:** One of the new containers costs a couple of thousand dollars, but they're rugged and can be shipped anywhere. They should encourage the development of the liquid helium business.

But there's another reason that the liquid helium business has not gone anywhere. For the last five or 10 years, it's been under allocation from the government because the

missile industry has soaked all the liquid helium up.

However, with new legislation going into effect next month, under which privately owned firms will be permitted to extract a crude helium stream from natural gas, and with the new 290-million-cu. ft./yr. Bureau of Mines plant at Keyes, Okla. (*Chem. Eng.*, July 25, 1960, p. 96), this liquid helium business will begin to take off.

**EDITOR:** Do you expect the helium business to develop fairly fast?

**MCCANDLESS:** I think in the next five years liquid helium will develop pretty fast.

**MURRAY:** Another reason why it will develop fast is space simulators.

**MCCANDLESS:** As the satellites, of which we were talking, go into outer space, they run into some peculiar conditions that are hard on materials. So there is a big need today to create these conditions on earth in order to pretest the materials. This need has resulted in a sudden blossoming of an entire new industry based on space simulators.

These are chambers inside which the conditions of outer space are simulated. They go from 2 ft. in dia. to the size of this room, and there's some indication they might go up to 100 ft. in dia. You might put a little component into these chambers or a 10-ft. space cabin for subjection to the conditions of outer space.

Space simulators have two cryogenic connotations. The first is that the walls of the chambers will be cooled with liquid nitrogen; secondly, most of them will have liquid helium or cold gaseous helium cryoplates to develop the very high vacuum of outer space.

**MURRAY:** We are going to produce the low-temperature helium refrigerator with simulator for the Air Force at Tullahoma, Tenn.; and that simulator will be 7 ft. in dia. and 12 ft. high—or something like that. And then we also will build the entire refrigeration system for the NASA simulator in Cleveland. That will be about the same size.

**HUFFARD:** And Arnold Air Force Base has bids out for one 30 ft. in dia. and 70 ft. high. And GE will

# BRIEFS

monochlorobenzene  
tetrachlorophthalic anhydride  
phosphorous acid



## VERSATILE INTERMEDIATE

Hooker monochlorobenzene serves as an intermediate in preparation of insecticides such as DDT; in the manufacture of dyestuffs such as sulfur black and brown dyes; in the manufacture of organic synthetics such as picric acid, phenol, drugs and perfumes. It is a good heat-transfer fluid, too... especially for condensing-vapor systems where steam pressures would be impracticable. Monochlorobenzene is widely used as a general solvent and as a paint and varnish remover. We offer it as a clear, colorless liquid sufficiently free from materials less volatile than itself so that, after drying, it will distill within 1°C. Check the coupon for data sheet.

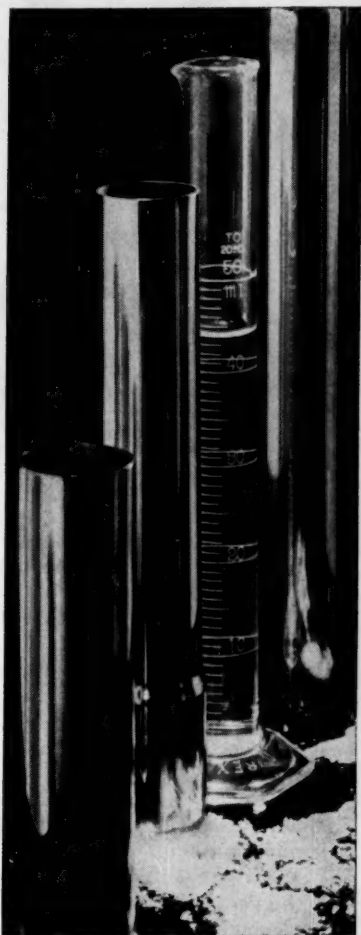
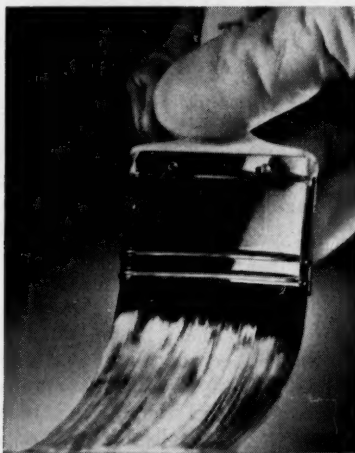
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If you are interested in imparting heat and fire resistance to alkyds, polyesters, plasticizers or similar products, tetrachlorophthalic anhydride may be just the intermediate for you to try.

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For more information, check here and mail with name, title and company address:

- ☐ Bulletins 46 and 47, Niagathal ☐ Data Sheet 788, Niagathal  
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Liquid hydrogen is loaded into 7,800-gal. truck at Linde plant.

have a 100-ft. simulator, won't they?

MURRAY: Yes. And Lockheed is going to build one.

EDITOR: How soon will you complete those that are now under contract?

MCCANDLESS: They'll be in operation within a year.

EDITOR: Will markets in space simulators develop before the electronics markets?

MCCANDLESS: Yes. And they will be bigger. Where these simulators are going, nobody can tell. This is so expensive, it puts a limit on how much the country can afford. On the other hand, it's so necessary, I'm sure we'll do a fair amount of it.

EDITOR: Well now, cryobiology is a market for liquid nitrogen. Is it also a liquid oxygen market?

HUFFARD: No. It's a market for liquid nitrogen and cryogenic hardware for the proper use of liquid nitrogen. It's well established and important only in the dairy cattle industry, as opposed to any other type of cattle or other animal.

MCCANDLESS: It's about a third of the way to saturation of the dairy industry.

EDITOR: Is it a definable percent of the nitrogen market?

MCCANDLESS: About 10%. This would be a Linde figure instead of an industry figure because we've been the ones who have been pushing it consistently, and I think we supply most of the nitrogen used by this market.

EDITOR: You've got 25% of the

nitrogen usage left over when you get finished with your rockets and missiles, and you're saying that as much as 10% of that goes into animal husbandry. And you say that that 10% only represents about a third of the saturation of the dairy industry?

MURRAY: Yes. And possibilities for cold semen insemination in breeding beef cattle, swine, sheep and turkeys are being studied. About 70% of the turkeys today are bred artificially but they're all bred with hot semen which means that they're inseminated within 48 hrs. of the time of collection. With cold semen, you can wait 48 years. Long after the bull is dead, the semen is still usable.

I would say that the beef cattle industry will be twice as big as the dairy, and there are more turkeys than there are cattle. The other animal industries combined might be as large as the entire cattle industry itself.

MCCANDLESS: Speaking accurately, the insemination industry is cryobiology. But here's another large spectrum of cryobiology that's in its commercial infancy: the freezing and storing of whole blood, or storing of blood fractions; the storage of human tissue at liquid nitrogen temperature; sooner or later, storage of bone marrow for replacement of the bone marrow in a human where exposure to radiation promises death.

EDITOR: How big is liquid nitrogen in the food industry today?

MURRAY: Most of the use today—

both for refrigeration-in-transit and for frozen-food processing—is on a semitrial basis.

EDITOR: Is much liquid nitrogen being used for refrigeration-in-transit outside of the food industry?

MURRAY: It doesn't amount to much at present except for frozen bull semen, but there are a few special uses such as transportation of liquid fluorine (*Chem. Eng.* Sept. 21, 1959, p. 78).

But it's the food industry that, five years from now, will represent the biggest market for liquid nitrogen. Dollar value will be in the eight-figure category. During '59, 67 billion lb. of perishable food and 8 billion lb. of frozen food were consumed. Refrigerated shipments were handled by more than 115,000 railroad cars, 40,000 trailers and 200,000 trucks.

HUFFARD: Refrigeration-in-transit will grow first\* but food processing with liquid nitrogen will eventually increase.

We are interested in building the machinery, for example, to use liquefied gases in food processing. With such equipment, you could pass a box of peas into a bath or atmosphere of nitrogen and then move it into transport vehicles.

MCCANDLESS: On a semiexperimental basis, Linde is supplying 10 food trucks in New York with cryogenic refrigeration. A thermostatically controlled cryogenic vessel in the truck releases liquid nitrogen whenever necessary, to bring air-space temperature back to a constant, desired level.

As for food processing, Linde has a semicommercial use coming up on high-quality baked goods. But for broad-scale use, we're not satisfied ourselves that the optimum technology and economics has been developed for cryogenic refrigeration vs. traditional ammonia refrigerators.

HUFFARD: Linde has not yet officially put its cryogenic products on the commercial market in the food industry. We expect that to happen some time this year.

\*Isbrandtsen, the shipping firm, is using a form of cryogenic refrigeration. The food itself is supercooled, then shipped in cars insulated with plastic foam.



## Hagan reports on Temperature Control

Daniel Fahrenheit graduated the measurement of hotness in 1714. Since that time the automatic control of temperature has been particularly challenging, involving the control of variables and time-delays, as well as the full range of controller actions (gain, rate, reset, bias).

Hagan temperature controllers have been successfully applied where product quality or quantity is a direct reflection of the precision regulation of temperature. Corrosion-resistant Hagan temperature measuring devices have been designed to

meet Division One area requirements; are extremely easy to maintain and trouble-shoot.

By the use of suppressed range measuring devices, Hagan can hold temperature as high as 3000°F to within one degree or less, and follow set points with a repeatability of 0.1% full range. As an example of really precise control, Hagan Powr-Mag is controlling glass fiber drawing dies operating at 2200°F. Despite wide variations in glass melt temperature, die temperature fluctuation is limited to less than 0.25°F.

Measuring and regulating all the variables that enter into process control is a part of Hagan's forty years of experience in the design and manufacture of instrumentation and control elements. For information on the complete Hagan line of electronic, pneumatic and hydraulic controls, write or phone HAGAN CHEMICALS & CONTROLS, INC., Hagan Center, Pittsburgh 30, Pennsylvania. Telephone WALnut 2-3737.

**HAGAN** 

## CPI News Briefs

- Processes
- Plants
- Offices
- Companies
- International

### Processes

Another hydrodealkylation process will soon be in commercial operation. Humble Oil & Refining is building a toluene dealkylation plant at its Baytown, Tex., refinery that will turn out 25 million gal./yr. benzene, raising total benzene capacity to 55 million gal./yr. Other hydrodealkylation processes in existence: Ashland-Universal Oil Products' Hydeal process and proprietary flowsheets of Sun Oil and Union Oil. (*Chemtator*, July 1, 1960, p. 61).

Sulfur "submarines" may be the answer to cutting sulfur transportation costs, believe engineers at Southwest Research Institute, San Antonio, Tex. They propose that molten sulfur as it comes from the ground be cast into a hull shape, leaving just enough void so that the hull will barely float. When the sulfur hardens, the sub (and perhaps others in tandem) can be towed behind an ocean-going tug. This would eliminate the need for full-size freighters and would also reduce product contamination and the number of handling steps.

Surface coatings capable of withstanding heat in excess of 500 F. are being piloted by Borane Chemical Corp., Montebello, Calif. Materials are produced by a patent-applied-for allyl chloride cracking process that is noncatalytic and uses near-atmospheric pressures. Products include diallyl terephthalate, diallyl pyromellitate and a number of boron derivatives in monomer form.

First producer of fumaric acid by the Scientific Design process (*Chemtator*, Aug. 8, 1960, p. 53) will be Heyden Newport, which is

building a plant at Garfield, N. J., of unspecified capacity. Scientific Design is also erecting a 24-million-lb./yr. maleic anhydride plant for the firm at the same site. Fumaric unit will isomerize a portion of the maleic acid stream coming from the benzene-oxidation step.

Selective plating process is now being marketed by Selectrons, Ltd., New York. By using a special power pack, plating styluses, and nontoxic, generally basic, electrolytes, process deposits many metals and alloys on almost any conductive base material. Process is claimed to be suitable for prototype work, production of parts needing plating in small areas, and for maintenance and repair.

A unique chemical pulp will be produced by West Virginia Pulp & Paper via an undisclosed process being installed at its Luke, Md., mill. Coupled with a new development in paper coating, pulp is said to furnish a thin, opaque printing paper comparable in quality to that made from groundwood pulp. New unit is slated to be operating by mid '61.

### Plants

Hercules Powder Co., Wilmington, Del., is starting construction of a

#### AICHE Offers Extra Feature at New Orleans

In conjunction with its technical meeting at New Orleans, Feb. 26 through March 1, the American Institute of Chemical Engineers is sponsoring a petrochemical and refining exposition, the first of its kind.

Situated in the Municipal Auditorium, the exposition will offer more than 100 exhibits by vendors of capital equipment, supplies and chemicals. Sessions on the AIChE technical program concerned with petroleum refining and petrochemicals have been scheduled for rooms adjacent to the exposition floor.

second, multimillion-dollar polyolefin plant at Lake Charles, La., which will double the capacity of a similar facility that the firm is currently completing at that location. Combined capacity of the units: about 120 million lb./yr.

Petro-Tex Chemical Corp., Houston, will build a multimillion-lb./yr. tetrahydrophthalic anhydride plant at that city. This material can be substituted for phthalic anhydride in resin syntheses, and it also finds use as an insecticide or fungicide. Raw materials for the new facility will be butadiene and maleic anhydride, both of which can be supplied by Petro-Tex's other operations. Plant is due on stream late this year. (See *Chem. Eng.*, Jan. 23, 1961, p. 69.)

Monsanto Chemical Co. has completed a 50%-expansion program for its insecticides plant at Anniston, Ala. New annual capacity is 18 million lb. Plant produces parathion and methyl parathion insecticides, is said to be the largest manufacturing facility for these products in the world.

General Electric Co.'s Silicone Products Dept. is building a \$1-million plant at Waterford, N. Y., to produce new types of intermediate silicone chemicals. It will be housed in a two-story structure, will add about 5,000 sq. ft. of manufacturing space to the department's current facilities at the Waterford site. Start of operation is scheduled for the middle of this year.

Solar Chemical Corp., a Leominster, Mass., producer of polystyrene, has announced a \$5-million expansion program covering the next five years. About \$2 million will be spent for construction and equipment; the balance will be used for product and process development.

Rhode Island Atomic Energy Commission will have at its disposal a new, \$540,000 open-pool research reactor, which will be located at the state's atomic energy labora-

More CPI News Briefs  
Continue on page 195

The background of the entire page is a detailed technical drawing of industrial machinery, likely a waste treatment system. It features various components such as large cylindrical tanks, complex piping networks with numerous valves and flanges, and large circular structures that could be part of a filtration or separation process. The drawing is rendered in a schematic style with lines and circles, typical of engineering blueprints.

800

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### Polysulfide rubber enters the art world



The plaster statue of St. Anthony (foreground) was cast in cold-set polysulfide rubber molds from sculptor George Kratina's clay original (in the background). Use of polysulfide rubber marks the first successful reproduction of perfect surface texture and intricate detail in cast-sculpting without resorting to the tedious process of making multisectional molds in rigid media.

Made by brushing five pasty coats of polysulfide rubber over the clay model, the flexible mold was strengthened by a layer of burlap, fiber glass and asbestos before hardening. Tiny holes were then drilled through the jacket to break the suction, and the mold was removed in four sections (front, back, two hands).—Smooth-On Mfg. Co., Jersey City, N. J. 104A

### Varnish

**Diallyl phthalate varnishes boost resin's versatility as insulating material.**

Because of their satisfactory performance as molding materials for electronic components, diallyl phthalate resins (Dapon trademark) have recently been incorporated in varnishes that are particularly promising for protective coatings on capacitors, transistors, diodes, transformers, motor windings and similar parts.

The diallyl phthalate functions under continuous operating temperatures up to 300 F., and the isophthalate prepolymer meets the specifications of Class H (355 F.) insulating materials. When heated in the presence of peroxide catalysts, both resins are converted to three-dimensional materials but even non-catalytic cures can be obtained with diallyl phthalate at 475 F. for 15 min. A typical coating solution consists of 100 parts of diallyl phthalate in 114 parts of methyl isobutyl

ketone and about 5 to 6 parts each of butyl acetate and butyl benzoate. The coatings are then applied by dipping a particular component in this solvent solution, followed by drying and baking for cure. Very low run-off or dripping occurs because the solvent evaporates quickly and the uncured coatings are completely dry after the solvent is driven off.

Coatings on heat-sensitive parts can be cured at temperatures as low as 212 F., provided that the time is extended to 16 hr.

With the solvent ratio shown above, one dip will give a 2.5-mil coating, but thicknesses can be easily adjusted during dipping by altering the solvent ratio.

Reportedly, these coatings have shown excellent resistance to moisture, corrosive gases and liquids, fungus attack and aging over a wide temperature span.—Food Machinery & Chem. Corp., New York. 104B

### Enzyme

**New preparations are potent over a 2-8 pH range and temperatures up to 160 F.**

To this date, cellulase enzymes (standardized enzyme preparations that attack cellulose and other beta-glucosides) have lacked the ability to act under various pH and temperature conditions. But there is now on the market a new cellulase enzyme, Takamine 4,000, whose stability and activity under a wide range of conditions are reported as excellent.

This enzyme, with potency ranging from 4,000 to 12,000 cellulase units per gram, hydrolyzes and thus depolymerizes cellulosic materials. Its digestion of paper, cotton, wood, soybean hulls, barley gums and carboxymethyl cellulose occurs quickly and efficiently.

Takamine solutions can be used over a long period of time because

solutions of the enzyme at its natural pH of 5 are indefinitely stable at temperatures up to 100 F. They retain 88% of their original activity after 4 hr. at 140 F., and 43% after 4 hr. at 158 F.

The solutions show maximum activity at pH 3 to 3.5, with good activity at higher or lower acidities. For example, at the alkaline pH of 8, more than  $\frac{1}{2}$  of the optimum activity is still exhibited. And in a pH range of 2.2 to 3, 80 to 90% of the original activity is retained when solutions of the enzyme are held at 100 F. for 1 hr.

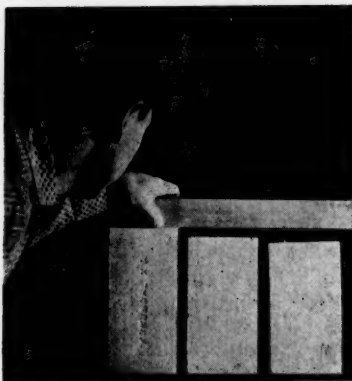
According to recent research, the new enzyme can find applications in:

- Brewing—to increase body of finished beers.

- Essential oils—to aid in extraction of essential oils and other natural flavors by breaking down cell walls.

- Septic systems and drain cleaner—to destroy paper and other wastes.

- Pharmaceuticals—to aid in digestion of bulky matter that causes discomfort.—Miles Chemical Co., Elkhart, Ind. 104C



### Refractory

**Material won't deform under loading, resists thermal shock.**

A mullite-bonded corundum brick is reported quite effective in preventing the spalling and cracking of furnace linings that must cope with heavy loads and temperatures as high as 3,200 F.

This tough refractory, known

as Korundal XD, has been produced by a new process that increases the density of the bricks in order to prevent furnace fumes and slags from seeping through the pores and weakening the lining.

According to R. E. Birch, research director of Harbison-Walker, "the XD development has increased by several hundred degrees the temperature at which furnace walls will show no deformation under load. In fact, the ability to withstand loading at high temperatures is so highly developed that special tests of long duration were devised for establishing its limiting properties."

Standard testing procedures for alumina refractories apply a loading of 250 lb. at the end of a brick and measure its subsidence after 90 min. at 2,900 F. But Korundal XD when undergoing this ASTM test showed no subsidence even with loading raised to 1,000 lb.

Increasing the temperature to 3,000 F., while holding different bricks under 250-lb. loads for 100 hr., had no effect on the Korundal brick (see picture) but caused subsidence of 5.1% and 9.6% in other alumina refractories.

This material has been used successfully with iron slags and in checker chambers. Because of its high resistance to thermal shock, Korundal makes a good kiln furniture in operations where cordierite and silicon carbide might fail, and is also used as skid rails in slab heating and enamel

melting furnaces.—Harbison-Walker Refractories Co., Pittsburgh, Pa. 105A

### Cationic surfactant

**Foaming agent for oil wells will work even in salt water.**

Oil wells that are beset by water encroachment usually run into high operating expenses because even small amounts of water can cause the dislodged sand and shale to ball up and possibly stick in the drill pipe.

In such cases, foaming agents injected in the air stream during drilling can eliminate this problem. "Armomist" is the latest foaming agent produced. It forms a light foam that, unaffected by high concentrations of solids, possesses corrosion inhibiting properties and can also work as a shale conditioning agent.

Chemically, Armomist is a fatty acid amine of low viscosity and with a pour point below 0 F. that allows its use at extremely low temperatures. It lowers the surface tension of the water and, although it is a cationic surfactant, remains effective even where the water has a high salt content.

Field tests indicate that this product also tends to prevent the sides of the hole from collapsing. According to present experience, Armomist gives satisfactory re-

### —Newsworthy Chemicals—

#### Page number is also reader service code number

Polysulfide rubber enters the art world.....	104A
Diallyl phthalate resins get into insulating varnishes.....	104B
Cellulase enzyme is potent over 2-8 pH range and up to 160 F.....	104C
Mullite-bonded corundum resists thermal shock.....	105A
Cationic surfactant works even in salt water.....	105B
Sulfamic acid removes carbonate and iron oxide scales.....	106A
Epoxy-rubber paint applies easily, reflects heat.....	106B
Hydrazine flux in core solder won't corrode joints.....	106C
Fungicide-bactericide is now used in maintenance paints.....	106D
Iron-oxide pigments for inks are transparent and nontoxic.....	106E
Molecular sieves of high crush strength are available.....	106F
Amine complex blended with isopropanol inhibits corrosion.....	106G

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sults in concentrations ranging from 0.15 to 0.20%.—Armour Industrial Chemical Co., Chicago, Ill. 105B

### Acid cleaner

**Sulfamic acid powders remove carbonate and iron oxide scales.**

Carbonate scales and iron oxide deposits, well known problems for anyone working with boilers, heat exchangers, process vessels and piping, can be removed with two quick-acting chemical treatments.

Both in powder form, Cleaners 1331 (an alkalinity-pH depressant) and 1332 are based on sulfamic acid ( $\text{NH}_2\text{SO}_3\text{H}$ ), which is a stable, high-melting (200 C.) crystalline solid with strongly acidic properties. This acid, when in contact with calcium carbonate, yields calcium sulfamate, a salt that dissolves completely in water.

Tough carbonate scales that clog pipes and tubes can thus be easily dissolved. And deposits of iron oxide may be removed by adding 1 lb. of NaCl to Cleaner 1332 because formation of ferric chloride accelerates the solution of iron oxide as iron sulfamate.

These cleaners, also useful in removing beerstone and milkstone, contain over 95% active acid and are much safer to handle because they come in a dry powder form.—Ionac Chemical Co., Birmingham, N. J. 106A

### Coating

**Epoxy-rubber paint features ease of application, reflects heat.**

Specially compounded to eliminate on-the-job-mixing of two part paints, Formula M-146 is an epoxidized rubber coating that promises reduced costs in the maintenance of ammonia tanks.

The coating, highly resistant to anhydrous ammonia, hydrochloric,

sulfuric and phosphoric acids, has the advantage of requiring little, if any, surface preparation before application. Brushing off any loose rust or dirt is enough. The coating can then be applied to the bare metal surfaces or over old paint either by roller, brush or spray.

One coat is usually sufficient because this paint has good hiding power. Undisclosed pigments give this paint an intense blue-white color that reflects heat and reduces product loss caused by evaporation. Other ingredients keep it elastic, thus prevent paint chipping characteristic of ordinary tank enamels.

Resistant to salt spray and weather, Formula M-146 sets and bonds tenaciously to surfaces within 3 to 4 hr. without any special primers or thinners.—Spatz Paint Industries Inc., St. Louis, Mo. 106B

### Core solder

**Hydrazine flux vaporizes completely, won't corrode joints.**

For the first time, hydrazine flux has been incorporated into a core solder that combines the advantages of standard liquid fluxes while providing an integrated ratio of flux to solder for proper wetting.

Called H-32, this activated core solder can be used on all electrical and electronic parts and, unlike rosin fluxes, it leaves no residue to invite fungus attack.

Noncorrosive and nonhygroscopic, H-32 vaporizes completely at soldering temperatures thus eliminating cleaning and residue removal. It can soft-solder such metal surfaces as copper, brass, hot tin dipped, tin plate, zinc, silver plate, beryllium-, copper- and nickel-plated brass. Hydrazine flux is also reported to work effectively with all common solders of certain fusible alloys containing tin, lead, cadmium, bismuth, antimony. — Fairmount Chemical Co., New York. 106C

## Briefs

**Fungicide-bactericide Fungitrol 11** is a nonmetallic, nontoxic compound that goes into maintenance paints for meat packing plants, food plants, dairies and breweries where the product involved demands sanitary surroundings or where moisture and temperature conditions favor the growth of objectionable molds and bacteria. It is particularly active against certain strains of food organisms that can't be controlled even with mercury.—Heyden Newport Chemical Corp., New York. 106D

**Two iron-oxide pigments**, Mapico Yellow Low Opacity and Mapico Red, offer the transparency and nontoxicity needed in the can coating and packaging ink industries. When combined with aluminum pigment, they produce metallic colors in paints, inks and plastics.—Columbian Carbon Co., New York. 106E

**Molecular Sieves**, for use as a refrigerant desiccant, now come in a new grade (4A XH) that has a crush strength three times that of standard beads, and shows better than three times the resistance to attrition losses. Their somewhat lower water capacity is partly offset by a higher bulk density.—Linde Co., New York. 106F

**An amine complex** of high molecular weight, blended with isopropanol, prevents the attack of hydrochloric acid on various metals. Called Atcar HC, this amber liquid dissolves easily in HCl and forms a protective organic film on surfaces such as copper, mild steel, stainless and high carbon steel. Product is used in pickling and acid cleaning.—Atlas Powder Co., Wilmington, Del. 106G

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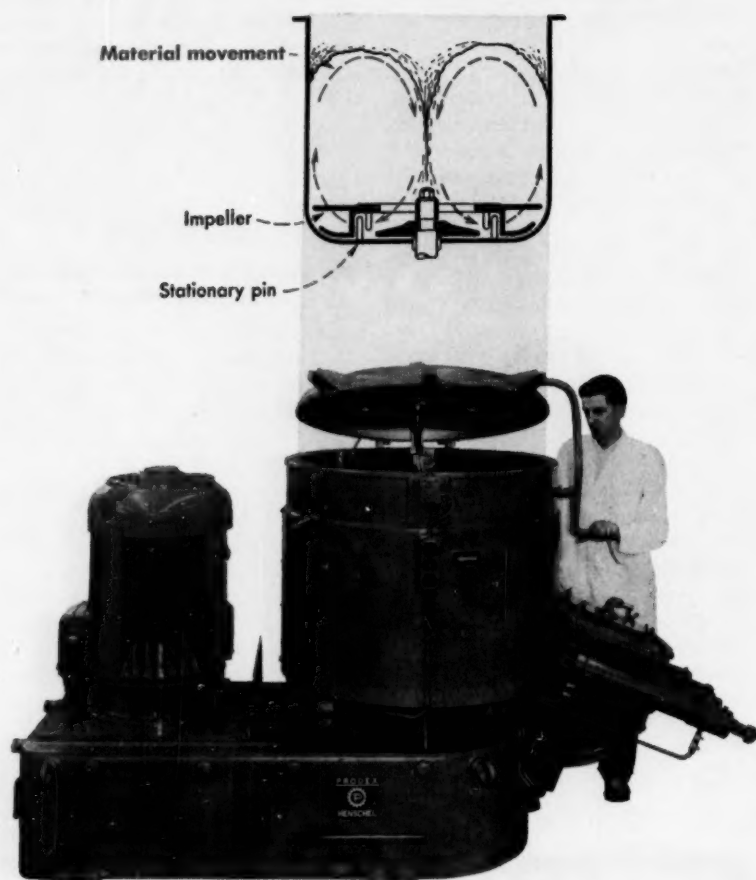
ized and readily interchangeable. Plant expansion costs less because Deming pumps are designed for adaptation to your growth requirements.

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save time on all three steps because it:

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The biggest time saver in the cycle is the mixing step itself. Mixer's propeller-like impeller rotates at peripheral speeds of 150-200 ft./sec., breaking down agglomerates and intimately dispersing all ingredients. Result: mix-

ing times are cut up to 90%.

A typical operation to prepare paint (blue pigment in titanium dioxide) may require 30 min. of mixing in a ribbon blender, followed by two passes through a disk grinder to produce the right product particle size. Same job in a P-H unit requires only 2½ min., according to the manufacturer.

► **It's Also a Dryer**—The large energy transfer to the mixer charge can be used in another manner. After the short dispersion cycle, mixing can be continued, thereby heating the charge to drive off solvents or moisture. In vacuum construction, unit may actually be used as a dryer. Heat necessary for evaporation is generated by friction, can be augmented by a heating jacket surrounding the mixing chamber. Mixing cycle for mixing alone is usually so short that heat buildup is negligible.

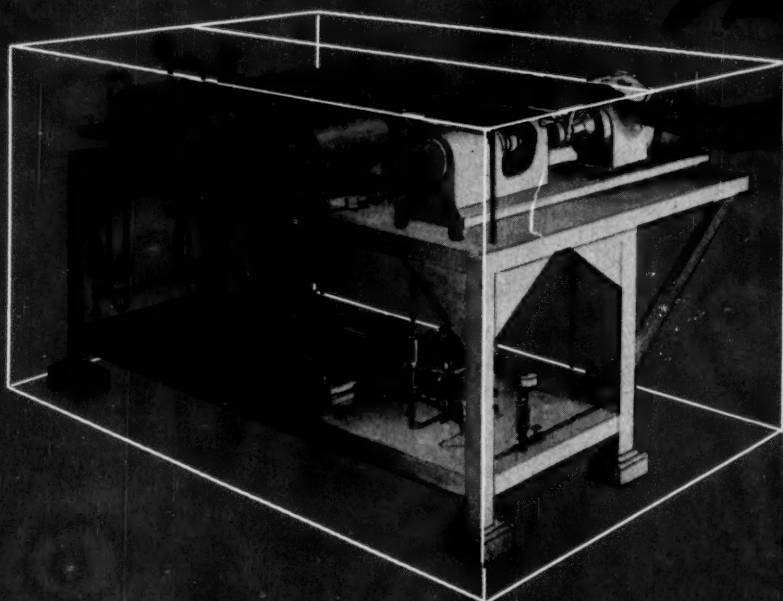
Applications for the unit take in the full gamut of mixing operations. Typical uses: blending powders with powders or beads, blending granules with granules, mixing powders with liquids, and densification, by reduction, of crumb or spongy materials to fine powders.

► **Mechanical Features**—Speed and versatility in mixing operations depend on unit's design. The mixing vessel itself is made with smooth walls of stainless steel or other alloys. It is jacketed for either heating or cooling. Charging hatches are provided in the lid so that mixer top need not be removed for introduction of solids or liquids. Lid has a quick-action lock for rapid opening when the mixer needs cleaning.

For swift emptying of blended materials, the discharge flap is air-actuated. A gasket prevents leakage during mixing cycle.

The four-bladed impeller recirculates material between closely spaced stationary and rotating pins, fluidizing the charge while providing high shear rates. Belt-driven, impeller has two speeds.

P-H mixers come in four sizes, with working capacities ranging from 0.25 to 11.5 cu. ft.—**Prodex Corp., Fords, N. J. 108A**



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# CONTROLLED CONTINUOUS POLYMERIZATION

VOTATOR\* processing equipment is used for continuous polymerization reactions in numerous installations. It affords fast, efficient, controlled processing not possible in batch reactors.

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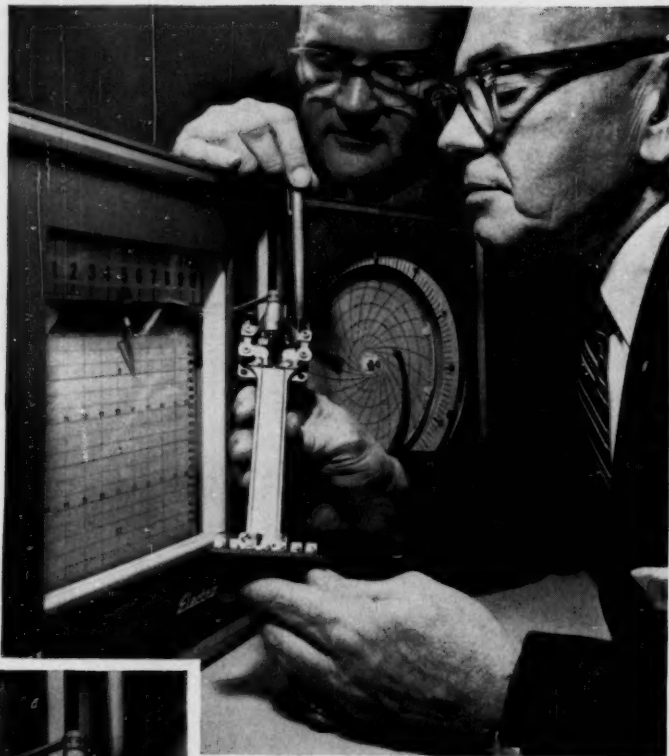
significant overall operating economy.

Rugged, dependable VOTATOR continuous reactors are fabricated by skilled craftsmen in strict compliance with ASME codes. Materials of construction are carefully selected according to the properties of products processed.

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\*VOTATOR—Reg. U. S. Pat. Off.





Heart of new potentiometer is the Stranducer, a strain-gage-type element that gives infinite resolution for incoming signals. Sealed unit has no moving contacts, promises long life.

*Cheaper, faster and more dependable than the slidewire instrument it supplants, this strain-gage potentiometer . . .*

## DOES MORE THINGS BETTER

After an extended period as the chief workhorse of measuring instruments, the slidewire self-balancing potentiometer may have to share the load—or even step aside—due to the advent of a new potentiometer that replaces the conventional slidewire with a

strain-gate-type rebalancing unit.

Called the ElectroniK 17, the new potentiometer is said to be faster, more sensitive and more reliable than the slidewire-type that it supersedes. One tipoff that it will probably find swift acceptance in its field: selling price is

15-25% lower than the \$700-900 range for the present ElectroniK 15, which was first introduced by the Brown Instrument Div. of Minneapolis-Honeywell Regulator Co. in 1941.

Principal advantage of the strain gage as a rebalancing element is that infinite resolution can be obtained. The number of points at which a slidewire potentiometer can come to balance is limited to the number of turns or convolutions on the slidewire.

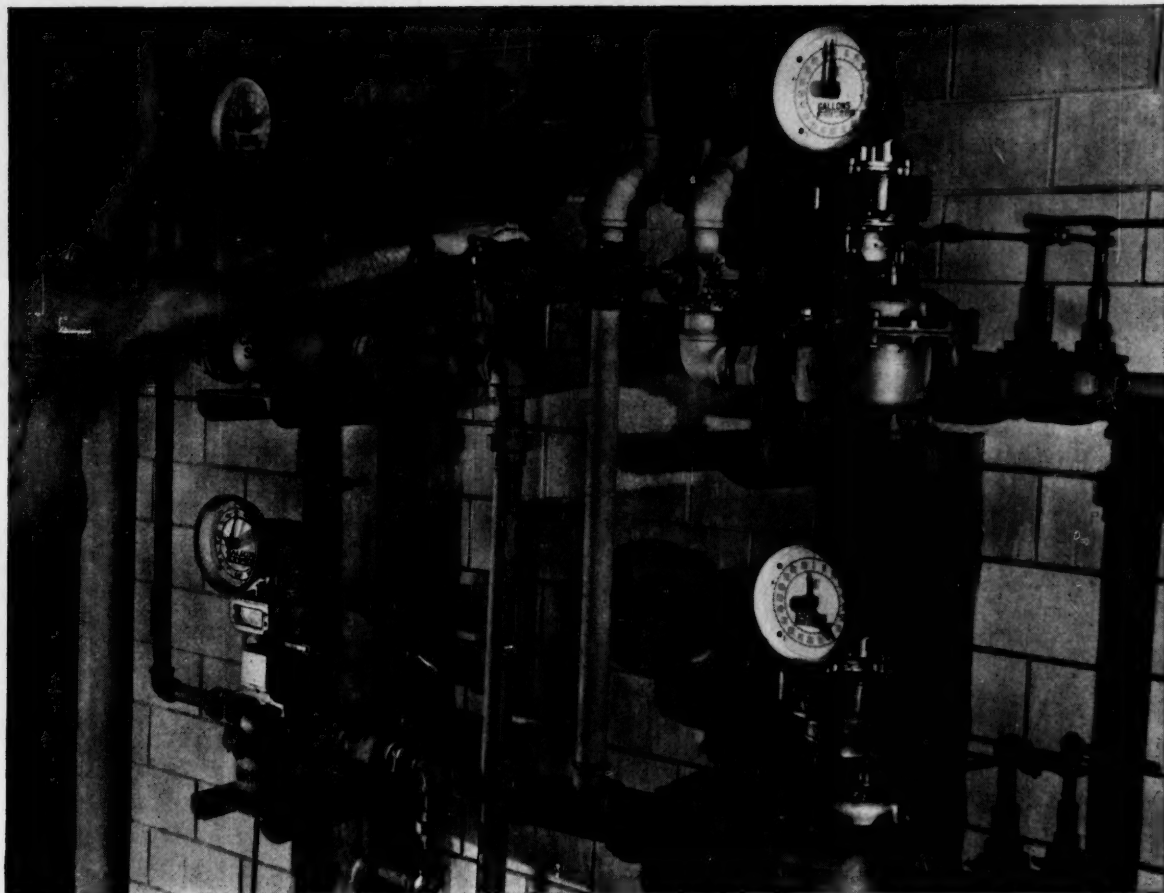
► **At the Heart**—Heart of the new instrument is the strain-gage element, Brown's Stranducer. It consists of four strands of wire that form the variable resistance legs (Wheatstone bridge) of the measuring circuit. The wires are looped over a pivot that is linked to a balancing motor.

A change in the instrument's input drives the motor in one direction or the other, increasing tension on two of the wires while decreasing it on the other two. The change in stress changes the electrical resistance of the wires and continues to change it until the bridge is electrically balanced. At this point, the motor stops moving.

Movement of the wires is extremely slight but precisely proportional to the degree of shaft rotation. The pen carriage or indicator is linked to the balancing motor; the same movement that balances the bridge also positions the pen or indicator.

► **Other Features**—In addition to the different rebalancing mechanism, the new unit incorporates some other features that add to its performance. Critical components are isolated within an electrical shield, which rejects stray signals that cause recording errors. One true reference junction compensates for all types of thermocouple actuation. Transistorized plug-in control units can provide auxiliary or zone control for up to eight set points.

The ElectroniK 17 is designed on the module principle. The display module is quickly convertible



## Meters with "mechanical brains" do your thinking at less cost

For controlling formulas, a Rockwell liquid meter thinks for itself. Once pre-set, it remembers the quantity, and shuts off automatically after each operation. Optional accessories include ticket printers for inventory and cost analysis; impulse contactors for remote registration; even controls to shut off the pump after delivery.

With this meter system there is no waiting for gauge tanks to fill, no bucketing, no errors, spillage or waste. In many cases one man can progressively formulate several batches at the same time.

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dling volatile liquids, you'll gain the safety of a closed piping system.

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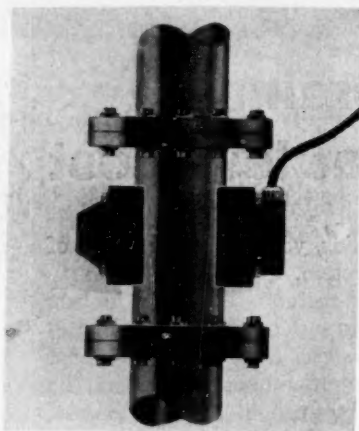




from a strip chart recorder to a circular chart recorder or a circular scale indicator. The drive module houses the Stranducer, range card and circuit board, amplifier and constant-current unit; all components are reached through a side panel.

These modules, mounted on a drawer-type chassis in the case, are connected to the control units and terminal board by a wiring drawbridge that folds out to allow the display and drive modules to be pulled completely out of the case while the instrument is operating.

Unit's flexibility makes it adaptable for measurement and/or control of such variables as pH, spectograph quantities, radiation, speeds, vacuum, mechanical strain and earth vibrations, in addition to common variables such as temperature, pressure, flow and humidity. — **Minneapolis-Honeywell Regulator Co., Philadelphia.** 110A



### Sludge pump control

**Sludge, slurry consistencies are maintained in flow lines.**

Utilizing harmless nuclear energy, new sludge reader starts and stops sludge pump in response to changes in concentration of solids coursing through the line. Low-energy source, beamed across the piping and its contents, spots density variations and triggers a detector that is mounted opposite the

nuclear beam. Detector then signals on-off pump control, which stops the pump if flow is below desired consistency, clears the line before restarting pump.—**Komline-Sanderson Engineering Corp., Peapack, N. J.** 112A

### Data processor

**Mobile unit collects, prepares information for computer use.**

Designed to eliminate the need for complex installations, this low-cost mobile data-handling system stands only 4 ft. high. But it collects and processes critical data on speeds, fuel flows, temperatures, pressures and a host of other variables that have to be measured during processing and testing operations, and fed into computers.

Raw test data normally traverse a maze of extensive data-processing systems before their format is suitable for computer entry. New mobile unit is said to provide considerable savings in time, computer rent, and convenience. It handles up to 48 analog inputs with a resolution of  $\pm 10$  microvolts and  $\pm 1\%$  accuracy, digital conversion at a maximum word rate of 3.8 kc. Unit's data output is on magnetic tape.—**Radiation Inc., Melbourne, Fla.** 112A



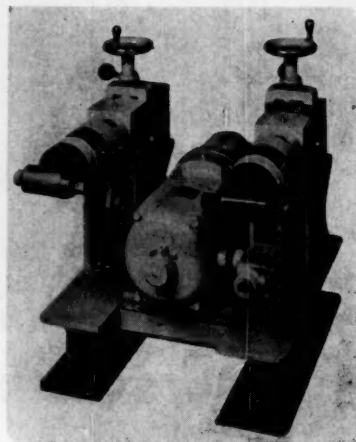
### Fiberglass box truck

**Lightweight, watertight box unit bulk-handles liquids or solids.**

Molded of fiberglass-reinforced polyester resin, box truck construction is said to be corrosion

resistant to mild acids and alkalis, lighter than aluminum, and more economical than stainless steel.

Units move on casters and can be nested for storage. Three sizes are available (ranging from 16 to 21 cu. ft.), with level- or tilt-mounted swivel or rigid casters. All models have smooth inside surfaces and rounded corners, thus preventing dirt accumulation and facilitating cleanups, and can withstand temperatures of  $-40$  to  $212$  F.—**The Hamilton Caster & Mfg. Co., Hamilton, Ohio.** 112C



### Proportioning pump

**Unit delivers small volumes of fluid at high pressures.**

Where small volumes (0.84-6,144 gal./hr.) of fluid have to be handled at pressures as high as 30,000 psi., this chemical-proportioning pump is effective. It features adjustable stroke length, rugged construction throughout, and a choice of four models: simplex or duplex,

**MORE NEW EQUIPMENT**  
(continued on page 206)

For More Information about any item in this department, circle its code number on the Reader Service Postcard (Page 227)



**KIMAX®**  
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**PIPE**

## **Your product stays pure... because KIMAX resists corrosion!**

Do your present process pipe lines guarantee the purity of your product? If not, consider KIMAX Tempered Glass Pipe.

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sudden temperature differentials from steam to cool liquids.

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almost as quickly and easily.

And KIMAX Glass Pipe is economical . . . initial costs compare favorably with other pipe materials. Installation cost is usually less and maintenance cost is practically nil.

For more information about KIMAX Glass Pipe write Kimble Glass Company, a subsidiary of Owens-Illinois, Toledo 1, Ohio.

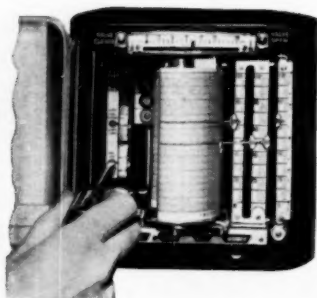
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**All adjustments**, including Gain, Reset and PRE-ACT\* responses are calibrated in specific units and are made with a screwdriver.

**This elimination** of 'blind adjustments' is another example of the careful attention to detail that has gone into the design of the Taylor TRANSCOPE line of Instruments. Important details that help lower your processing costs while maintaining the highest standards of product quality.

▼ ▼ ▼

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# U.S.I. CHEMICAL NEWS

February

★

A Series for Chemists and Executives of the Solvents and Chemical Consuming Industries

★

1961

## Cesium Metal Is Now Being Produced by U.S.I.

Cesium metal, 99%+ pure, is now available in commercial quantities from U.S.I. Production facilities can turn out 50-75 pounds per week. Current price is pegged at \$100 per pound in 1, 5, or 20 pound cylinders. Substantially larger quantities could be produced if new, large-volume applications should develop.

Cesium is currently used in minute quantities in TV cameras and electron multiplier photoelectric cells. Many potential applications are based on cesium's ability to ionize easily. Because of this, it may some day be needed in large volume for thermonuclear converters based on plasmas, and as a propellant in ion propulsion motors for space ships. Other less exotic applications for cesium include: grain refining agent for other metals such as aluminum; heat transfer



## ATTENTION: Ethyl Alcohol Users

The Internal Revenue Service of the U.S. Treasury Dept. has issued Publication No. 443 (9-60), covering current regulations on "Distribution and Use of Denatured Alcohol and Rum". Publication No. 444, issued at the same time, covers "Distribution and Use of Tax-Free Alcohol". Both booklets can be obtained, at a cost of 25¢ each, from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D. C.

The information contained in these booklets has been summarized in the new Government Regulations Supplement to the U.S.I. Ethyl Alcohol Catalog, offered in the November Chemical News. Because of great demand, this supplement has been reprinted and revised to contain all regulations changes up to Dec. 1, 1960. Copies of the Regulations Supplement and the Alcohol Catalog may be obtained from Technical Literature Department, U.S.I. Chemical News, 99 Park Avenue, New York 16, N. Y.

## Naphthalene Shortage Eased By Sale of Mixed Streams

Shortage May Be Eased Further by Use of Economical Sodium Desulfurization Process for Mixed Streams.

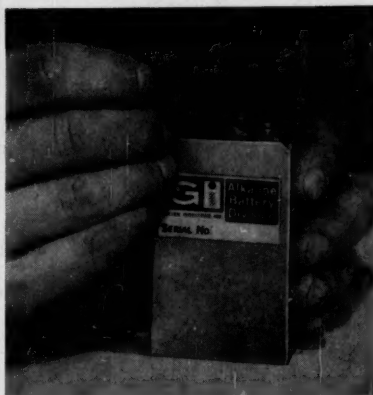
Coal tar naphthalene suppliers are now making mixed streams—naphthalene plus isomers—available to phthalic anhydride producers. Isomers can also be converted to phthalic, although yield is lower than for straight 78° naphthalene, and some processing problems are encountered.

### Titanium and Zirconium Used as Bonding Agents In Ceramic-to-Metal Seals

A ceramic-to-metal seal which forms a true molecular bond is one of the unique features of a new, rechargeable nickel-cadmium battery designed for outer-space service. It is reported that the technique developed to achieve this bond now makes possible the sealing of large ceramic inserts to flat metal surfaces.

A key to the process is said to be the use of a thin layer of bonding metals, such as titanium or zirconium, between ceramic and base metal. Fusing at 1,000°F. in a vacuum is reported to yield a complex alloy from the ceramic, base metal and bonding metals.

The technique is used in the new battery to join the iron-nickel contact terminals, the ceramic insulator and the body of the cell. The seal is claimed to be truly hermetic, giving high reliability and long life in outer space.



Pencil points to ceramic-to-metal hermetic seal on new, rechargeable nickel-cadmium battery designed for outer space service. (Photo courtesy Gulton Industries.)

### Other Solutions to Shortage

This is the first step in easing the naphthalene shortage resulting from low steel production. Suppliers are also working on maximum conversion of coal tar to naphthalene and isomers, even at the expense of tar acid, solvent and creosote production. Also, more petroleum naphthalene capacity is being built.

According to one report, mixed streams can be used by phthalic producers only in fixed-bed processes. These streams must be desulfurized further for fluid-bed use. Consequently, further easing of the situation might result from use—by mixed-stream suppliers and/or phthalic makers—of an economical desulfurization process recently developed by U.S.I. Investigations are currently underway.

### Desulfurization Process Uses Sodium

This is a semi-continuous, commercial process for desulfurization through



## Polyethylene Lab Being Built by U.S.I. Abroad

A new customer service laboratory is being constructed at Baar, Switzerland, by U.S.I.-International—known officially as Sales and Development Company of National Distillers and Chemical Corp. (International) S.A. Occupancy is scheduled for about July, 1961.

The new facility will support the efforts of U.S.I.'s European representatives for PETROTHENE® polyethylene resins. It is designed to help them give their customers the close technical assistance the polyethylene market demands.

The laboratory's processing and test equipment will be designed to meet European standards and operating conditions. It will demonstrate techniques for processing polyethylene, and will conduct research and evaluation studies to help improve products and develop new markets.



February

★

# U.S.I. CHEMICAL NEWS

★

1961

## CONTINUED

## Cesium

medium in power generators. Cesium also has potential in large catalytic processes since it can be recycled by sodium reduction of the recovered chloride.

The commercial availability of cesium is an outgrowth of U.S.I.'s research and development program on the use of sodium for metals production. This research has already resulted in the commercial availability of titanium and zirconium from U.S.I.'s affiliate, Reactive Metals Corporation.

## CONTINUED

## Naphthalene

treatment with 1.5% by weight of metallic sodium. Sulfur content can be reduced to under 0.05% at a cost of less than .5¢ per pound. Capital investment for a plant to treat 50-60 million pounds per year would be about \$50,000.

For further information on this process, send for the new U.S.I. technical data bulletin "Desulfurization of Naphthalene by Sodium". Address Technical Literature Dept., U.S.I. Chemical News, 99 Park Ave., New York 16, N. Y.

## TECHNICAL DEVELOPMENTS

Information about manufacturers of these items may be obtained by writing U.S.I.

**Heavy water** can now be obtained on rental basis, for intervals from 3 months to 2 years. Cost depends on time used and amount of dilution resulting. Said to cost much less than purchasing or producing. **No. 1680**

**Seven special slide rules and calculators** designed for chemists are described in literature now available. Help solve problems on radioactivity, structure of elements, chemical equations, pH, humidity, solutions, gases. **No. 1681**

**Desulfurization of coke oven BTX by sodium** is subject of new technical data bulletin now offered. Describes process, results and economies, tells when to use, gives costs. Includes tables and illustrations. **No. 1682**

**Guide to translations of Soviet research** in chemistry and metallurgy can now be obtained. Booklet describes 49 outstanding titles, including books, monographs, symposia, journals, and collections. Gives prices. **No. 1683**

**New adhesive for multiwall polyethylene bags** now on market. Used to spot-cement intermediate ply of polyethylene sheet, top and bottom, to adjacent layers of kraft. Said to form strong, positive bond. **No. 1684**

**Circulating thermostats** are now available which can be used for either heating or cooling, for control of liquid temperatures in a closed system, or for circulation of liquids to outside sources such as refractometers, viscosimeters. **No. 1685**

**A new statistical technique** for investigations involving a large number of variables—10, 20 and more—is described in literature now available. It is a non-mathematical method said to give fast and simple answers. **No. 1686**

**Para-chlorothiophenol** is now being marketed commercially. Material is suggested as intermediate for making oil additives, agricultural chemicals, plasticizers, rubber chemicals, dyes, wetting agents, stabilizers. **No. 1687**

**New, revised edition of National Fire Codes** can now be purchased. Incorporates important changes in many fire safety standards. Compiles 181 standards in 7 volumes. Includes 42 new or revised fire safety standards. **No. 1688**

**New recording/controlling instrument** employing fluorescence techniques is claimed to combine operating simplicity with high sensitivity and long-term stability. Provides signals for continuous recording or automatic controls. **No. 1689**



Welders work on new, 7,000-ton ammonia storage tank, to be completed this month at U.S.I.'s Tuscola, Ill. plant. Tank uses relatively new technique of storing refrigerated ammonia at atmospheric pressure rather than storing it in pressurized tanks at moderate temperatures.

Shown under construction is inner tank, 88 feet in diameter and 56 feet high, which holds ammonia. This tank is surrounded by 2½ feet of insulation, and another steel tank which keeps moisture out of insulation. Ammonia is maintained at temperature of minus 28°F. by surface evaporation of ammonia itself. Evaporated ammonia is recompressed, condensed and recirculated to tank.

## PRODUCTS OF U.S.I.

**Heavy Chemicals:** Metallic Sodium, Anhydrous Ammonia, Ammonium Nitrate, Nitric Acid, Nitrogen Fertilizer Solutions, Phosphatic Fertilizer Solution, Sulfuric Acid, Caustic Soda, Chlorine, Sodium Peroxide.

**Organic Solvents and Intermediates:** Normal Butyl Alcohol, Amyl Alcohol, Fusel Oil, Ethyl Acetate, Normal Butyl Acetate, Diethyl Carbonate, DIATOL®, Diethyl Oxalate, Ethyl Ether, Acetone, Acetoacetonilide, Acetoacet-Ortho-Chloranilide, Acetoacet-Ortho-Toluidide, Ethyl Acetoacetate, Ethyl Benzoylacetate, Ethyl Chloroformate, Ethylene, Ethyl Sodium Oxalacetate, Sodium Ethylate, Urethan U.S.P. (Ethyl Carbamate), Riboflavin U.S.P.

**Pharmaceutical Products:** DL-Methionine, N-Acetyl-DL-Methionine, Urethan USP, Intermediates.

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**MICROTHENE**... Finely Divided Polyethylene Resin.

**Animal Feed Products:** DL-Methionine, MOREA® Premix (to authorized mixer-distributors).



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## Heavy-Water Plant Melds New Features

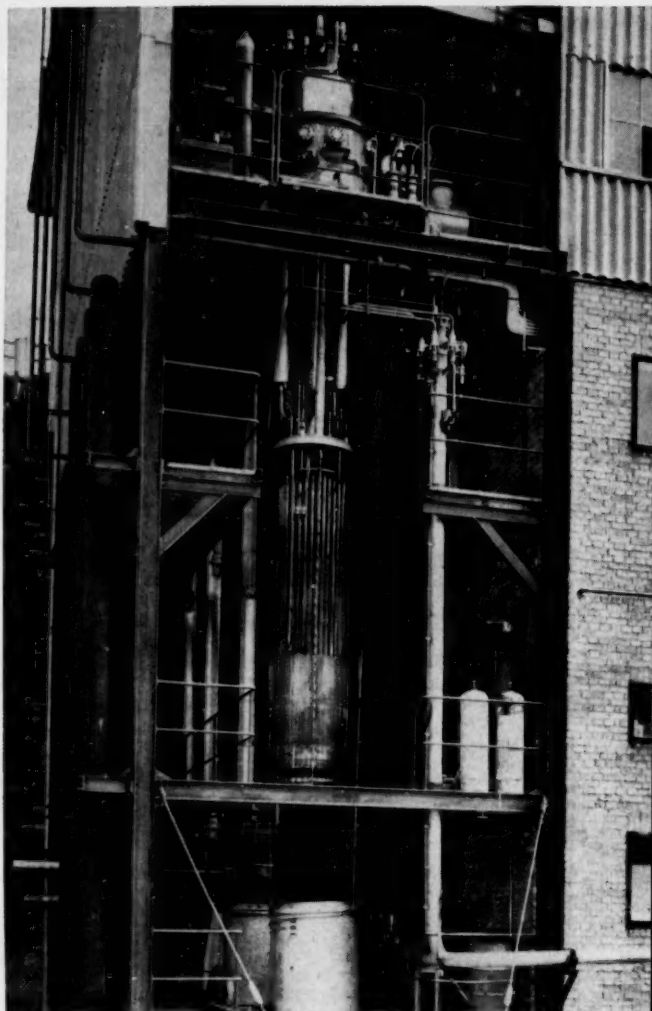
Swiss unit splits rectification into two steps, combines them with electrolysis in simple, direct route to  $D_2O$ .

N. P. CHOPEY, *Assistant Editor*

European technology has come up with yet another route for extracting heavy from natural water—a direct, simple one boasting a variety of process features. Developed by Sulzer Bros., Ltd., Winterthur, Switzerland, it is currently in use at a small plant operated by Emser Werke AG at Domat-Ems, Switzerland, which supplies its output to both local and French nuclear agencies.

Process follows a three-step path in extracting heavy water. First, natural-water feed is electrolyzed. Resulting deuterium-enriched hydrogen stream is then rectified at low temperature. Finally, deuterium-rich material from this step is oxidized, and the water formed is in turn rectified to yield the finished, 99.8%-pure product.

Strictly speaking, the electrolysis units aren't part of the heavy water plant. They belong to an ammonia synthesis facility that the firm operates at the same site, and the rectification units return

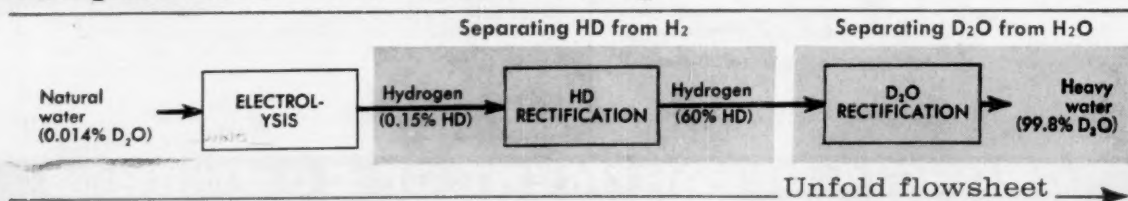


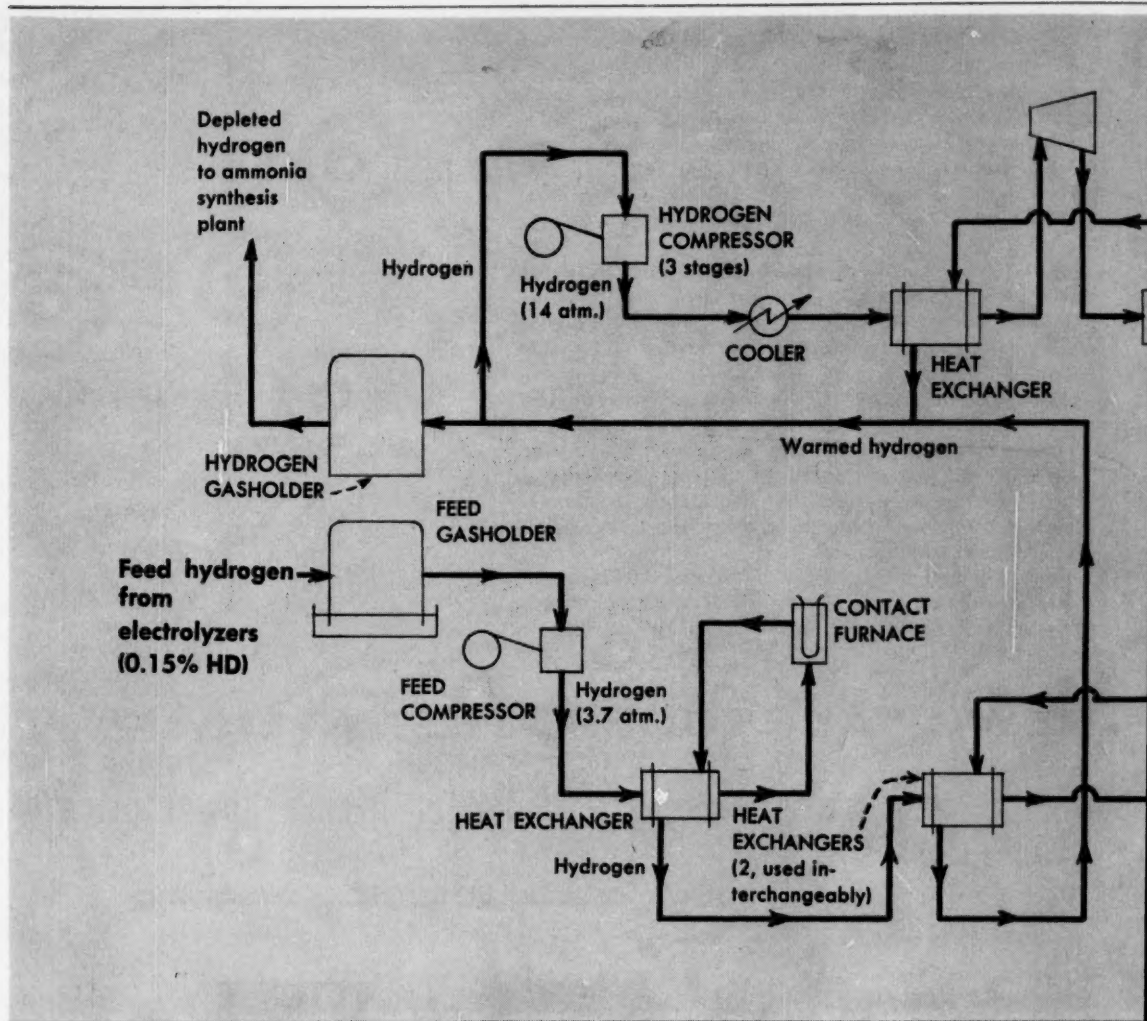
Kuhn column (shown above with jacket removed) contains parallel tubes for liquid-gas contact.

both depleted hydrogen and byproduct deuterium-lean water to the ammonia operation.

Emser Werke's heavy water plant is a small one; top production rate has been about 4 metric tons/yr., based on essentially continuous (8,000 hr./yr.) operation. Actual output, however, is tied to the ammonia operations, where the electrolyzers

### $D_2O$ plant features two rectification steps:





are operated mainly during summer months when power is inexpensive and readily available.

Because of this fluctuating operation and the tie-in with the ammonia plant, Sulzer feels the plant costs aren't easily compared with those of other heavy-water units. But the firm discloses that energy requirements, making up the principal operating cost, are 2 kw. hr./gm. of product, and avers that its process is competitive costwise with AEC's operations at Savannah River, S. C.

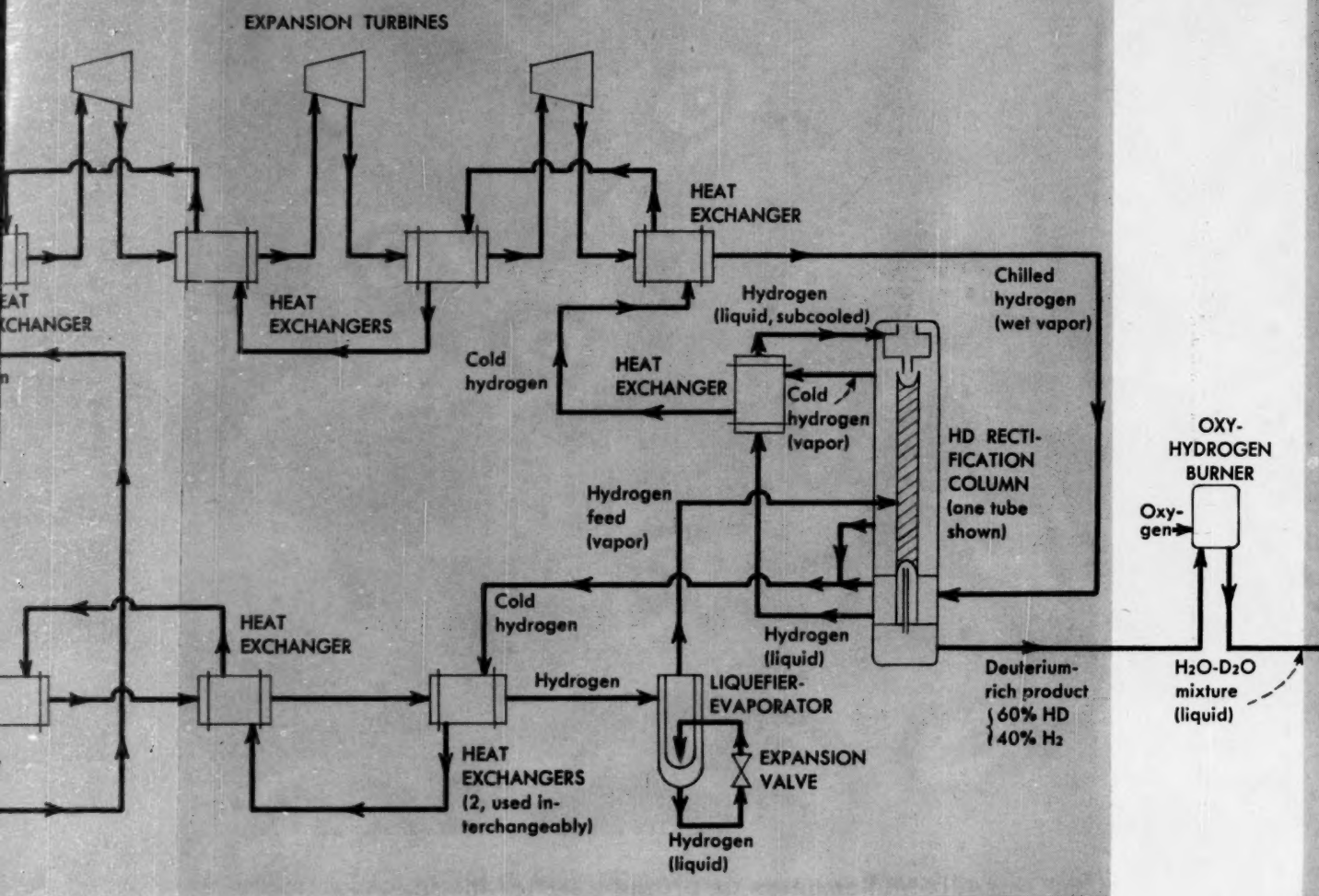
► **Features**—Unlike some heavy-water processes, the Swiss route steers clear of employing working fluids, such as hydrogen sulfide or ammonia. The hydrogen streams undergo no chemical conversion during processing, other than oxidation to water.

Each of the two rectification steps are carried out in a single Kuhn column. Developed by Basle University's Professor W. Kuhn in conjunction

with Sulzer (*Chem. Eng.*, Oct. 1956, p. 246), these columns provide effective separation of components having close boiling points. And, Sulzer points out that the splitting of rectification into two steps fosters plant flexibility, also allows regeneration of waste streams highly concentrated with heavy water.

The low-temperature-rectification section boasts many features of its own. Its hydrogen-liquefaction unit is believed to be the only one in the world that accomplishes cooling solely by heat exchange with recycle hydrogen and use of expansion turbines, without preliminary cooling by nitrogen. Plant uses oil-free, labyrinth compressors; insulation of heat exchangers, turbines and control units is by high vacuum. Regulating valves are remote-controlled by pressurized gas, minimizing refrigeration losses and giving greater





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freedom in valve placement during plant design.  
► **Following the Flow**—Electrolyzers in the ammonia synthesis plant (not shown above) are used in cascade for deuterium (heavy hydrogen) production, and undissociated water becomes successively richer in D<sub>2</sub>O as it passes through three electrolysis stages. Last stage carries out complete dissociation, and resulting hydrogen stream—about 14,300 scf./hr.—contains about 0.15% hydrogen deuteride. (At low concentrations, deuterium exists only in the form of hydrogen deuteride, or HD, molecules.)

This stream goes to the low-temperature unit. There it is first compressed, then goes to a contact furnace for oxygen removal. Heat exchangers cool the stream and remove water and nitrogen—which freeze out in the exchangers and are then removed by periodic thawing. Final purification consists of

liquefying the stream and re-evaporating the hydrogen. Resulting pure vapor is ready to enter the Kuhn column.

► **First Rectification**—A Kuhn column consists of a number of parallel, vertical tubes, in which descending liquid continuously contacts rising gas. In the low-temperature plant, the hydrogen enters each of these tubes through a capillary and is stripped of deuterium content by descending, subcooled liquid hydrogen. Column contains 90 tubes, operates at -420 F.

Deuterium-rich mixture accumulates at the bottom of the column, is withdrawn when HD concentration reaches about 60%. Meanwhile, hydrogen returns through the plant's heat exchangers. Part is taken for the refrigeration cycle and passes through the turbines in series; the rest returns to ammonia synthesis. Over-all material balance

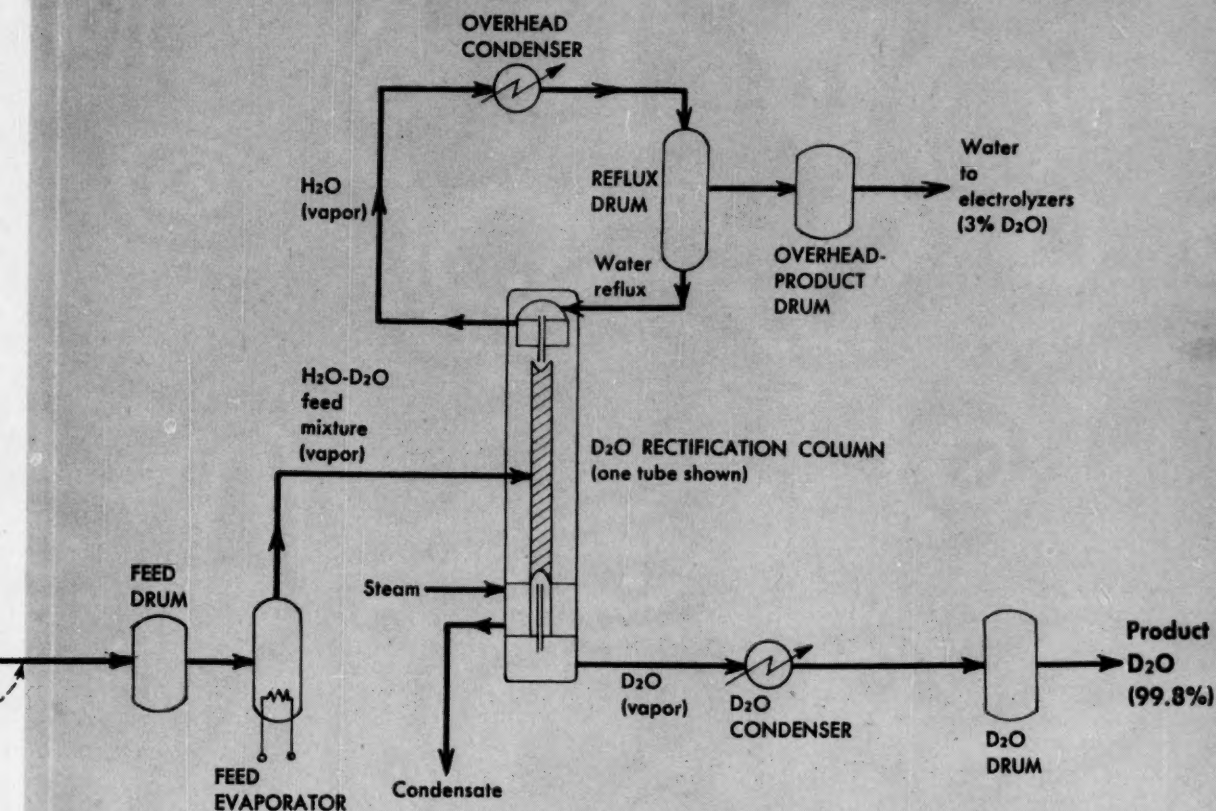
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## Separating D<sub>2</sub>O from H<sub>2</sub>O

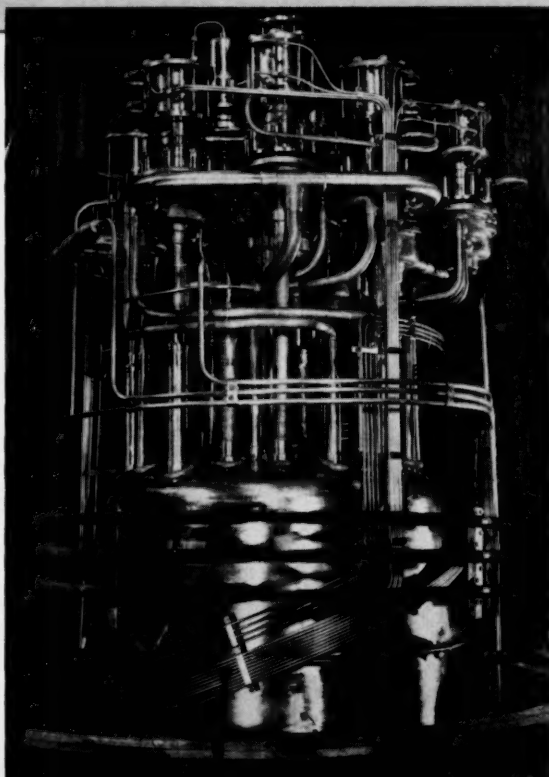


ows 99.75% of the hydrogen feed returning to the ammonia plant.

**Burn, Rectify Again**—Deuterium-rich stream is burned in a simple oxy-hydrogen burner, producing a mixture of ordinary and heavy water. Mixture is evaporated and fed to the second Kuhn column, which operates under vacuum at about 140 F.

Overhead from this column, containing 3% D<sub>2</sub>O, is condensed. Part of the condensate is sent back to the electrolyzers, and the rest is used as reflux liquid for the column tubes. This reflux absorbs D<sub>2</sub>O from the feed. D<sub>2</sub>O-rich liquid accumulating at the bottom is withdrawn as vapor, which is then condensed. This condensate, containing 99.8% D<sub>2</sub>O, constitutes the finished heavy-water product.

ve array on vacuum jacket is made possible by using pneumatic control instead of conventional handwheels. ▶





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These men are not opportunists. Most of them would do anything in their power to continue to teach. But with families to feed and clothe and educate, they just can't make a go of it. They are virtually

forced into better paying fields.

In the face of this growing teacher shortage, college applications are expected to *double* within ten years.

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MIX



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CHEMICAL E



# MIX-MULLER® means Controlled Dispersion



**"This Mix-Muller helps us produce better tile in less time."**

... John C. Elder, Factory Manager, Robertson Manufacturing Company, Morrisville, Pennsylvania

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The old system operated seven days a week on a continuous basis. With the Mix-Muller, we are able to produce the same production on a normal five day a 1/2-shift work schedule ... releasing manpower for other jobs."

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## In Summary ...

"The installation will pay for itself in reduced processing costs and increased production—notwithstanding the obvious benefits of vastly superior quality control."

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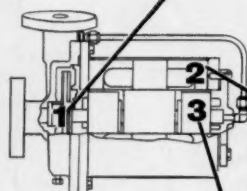
Two new features all but do away with bearing maintenance. A new automatic thrust balance design eliminates axial wear on the bearings by equalizing hydraulic pressures across the rotor and impeller. New front and rear carbon graphite bearings are three times as large, more than tripling radial bearing surface and therefore bearing life.

Motor life is greatly extended because the CHEMPUMP stator cavity is filled with a dielectric oil that increases heat dissipation from the windings. A specially designed relief valve protects the stator cavity against oil pressure buildup.

And you don't have to worry about "new product bugs": The new CHEMPUMP features have been field-proved in more than 100 field installations for over a year.

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For a full description of the new Series G CHEMPUMP, write for Bulletin 2050. CHEMPUMP DIVISION, FOSTORIA CORPORATION, Buck and County Line Roads, Huntingdon Valley, Pa.



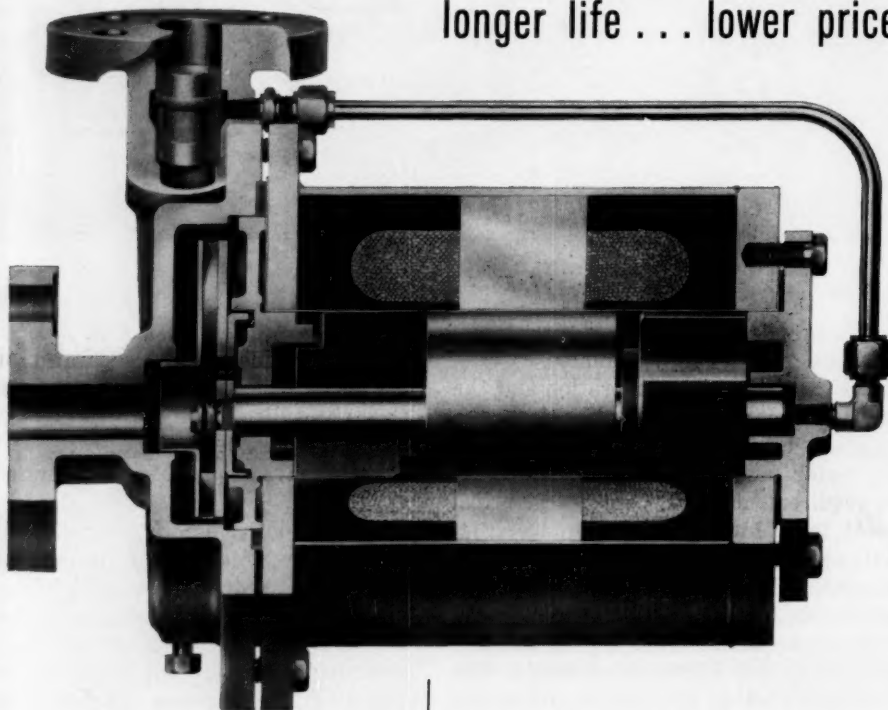
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Sugar Syrup  
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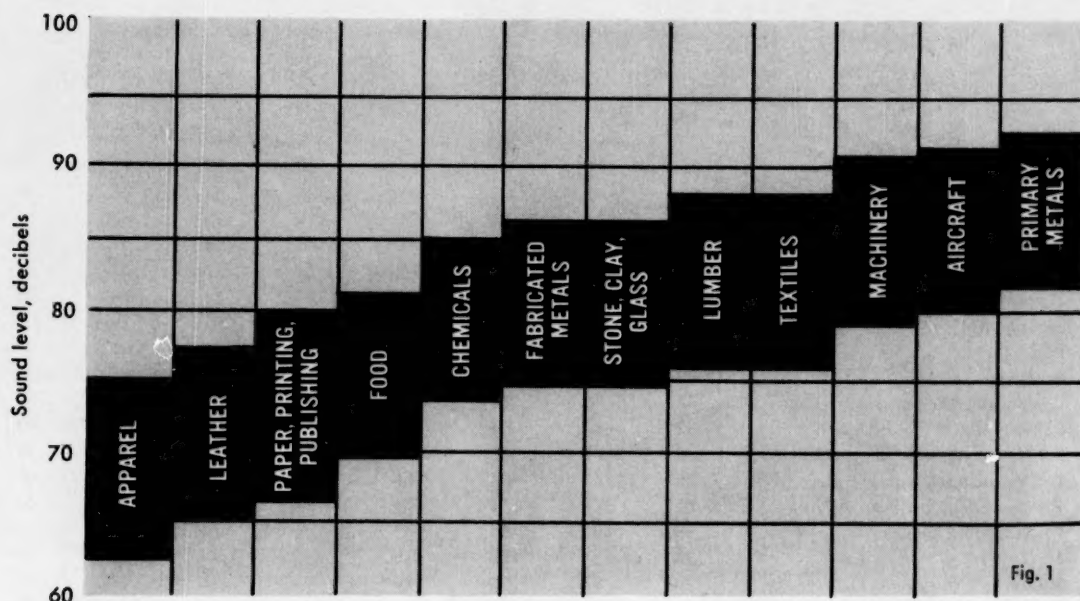


Fig. 1

## Sound Suppression in the Chemical Process Industries

ROBERT L. JACKS, *M. W. Kellogg Co.*

In the last ten years, noise levels in industry have increased considerably, because output per machine and the number of processes using machines have increased with growing productivity. Noise intensity in the plants has now reached the point where corrective measures are urgently needed for reasons of safety and efficiency. Psychological and annoyance effects on surrounding neighborhoods cannot be overlooked, either.

Hearing loss resulting from noise exposure has recently become of increasing importance and concern. Courts in New York have ruled that such loss resulting from exposure to industrial noise is compensable under state laws. In addition to this primary health hazard, there is also the danger to personal safety due to operators or nearby workers being unable to hear warning or alarm signals.

We also know that employee efficiency is greater in a pleasant sound atmosphere. This applies even to office personnel who may be working 200 ft. away from sources of loud noise. As one result of these findings, modern group offices today are often equipped with background music.

This elimination of what might be termed the annoyance effect also finds support from the action of neighborhoods adjoining industrial areas. The clamor from such groups for noise reduction is increasing and must not be treated lightly by designers and planners of future installations.

Before we further discuss the problems and corrective possibilities relating to industrial noise, we should clearly understand some of the basic features of sound technology.

Sound is produced in a variety of ways but is im-

**Acknowledgments**—This article had its inception in an AIChE symposium on "Noise in the Chemical Industry," presented at Montreal, Can., on April 22, 1958. The author is indebted to the following symposium papers for much of the subject matter in this article: "The Hazards of Noise Exposure" by Wayne Rud-

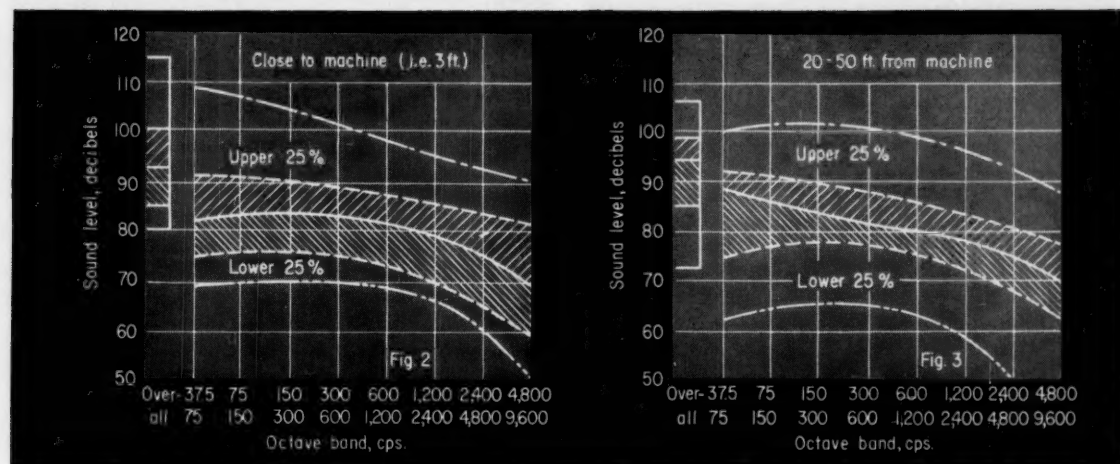
mose, Southern Methodist University, Dallas; "The Measurement of Noise" by Lewis S. Goodfriend, Noise Control, Scarsdale, N. Y.; "Noise With Your Chemicals?" by George L. Bonvallet, Rysdon Products Co., Chicago; and "Methods of Noise Control" by T. F. W. Embleton, Natl. Res. Council, Ottawa.



## Industrial sound levels (db.) at 3 ft. (Table I) and 20-50 ft. (Table II).

	Octave Bands, Cycles per Second							
	37.5	75	150	300	600	1,200	2,400	4,800
	75	150	300	600	1,200	2,400	4,800	9,600
Ink mill, noise of worn parts	76	82	86	85	89	82	72	70
Steel ball pigment mills	82	83	85	86	86	87	85	79
Pebble mill	79	75	77	75	74	73	67	57
Mixer, enamel components	76	74	73	74	80	67	57	—
Drum cleaning	74	77	80	76	74	75	74	65
Pigment mill, enamel grinding	69	72	76	75	75	73	69	56
Five-roll mill	105	110	109	101	89	82	79	80
Hammermill	98	93	92	97	95	94	92	96
Boiler room, blower	89	91	98	92	87	84	85	78
Compounding roll, plastics	87	86	84	84	90	84	79	77
Ball mill, plastic components	82	82	82	84	93	95	93	92
Fabric coating, low temperature	72	71	68	74	76	69	69	67
Fabric coating, low temperature	75	75	74	73	80	80	74	61
Fabric coating, low temperature	71	72	73	73	74	80	64	54
Rewind, fabric beaming	88	89	84	80	76	75	69	58
Rotary kiln	92	88	83	81	80	72	68	63
Rubber mill, tire rubber	99	97	90	89	84	78	77	74
Tread tubers, making tires	94	92	86	82	82	81	86	70
Curing press, rubber tires	89	87	86	85	87	85	88	88
Heavy service curing, tires	90	85	86	83	78	75	75	66

	Octave Bands, Cycles per Second							
	37.5	75	150	300	600	1,200	2,400	4,800
	75	150	300	600	1,200	2,400	4,800	9,600
Ink mill room	76	80	79	79	79	75	72	70
Pigment grinding	80	81	84	85	85	85	83	78
Pebble mills	76	70	70	71	68	68	62	47
Enamel mixing	71	68	66	65	70	59	50	43
Paint drum cleaning	74	77	80	76	74	75	74	65
Enamel component grinding	66	66	68	67	66	63	58	46
Rotary kilns	92	88	83	81	80	72	68	63
Vibrator, heavy chem. conveyor	91	89	83	78	81	78	81	78
Mixer, heavy chemicals	97	92	90	89	83	87	78	72
Gas compressor room	90	89	80	82	85	80	78	74
Catalytic cracking area	91	93	101	101	99	90	78	66
Pulverizing room, ball mill	85	85	85	85	92	94	93	92
Plastic molding area	100	92	89	86	87	77	78	78
Rubber mill department	95	92	86	84	77	74	72	66
Tread tubers area	94	92	86	82	82	81	86	70
Tire making	100	101	98	92	85	85	83	76
Tire making	92	88	91	92	85	83	83	84
Curing area, large presses	88	86	84	83	85	84	87	85
Curing area, misc. equipment	90	85	86	83	78	75	75	66
Tire making	92	85	87	77	74	70	67	60
Rubber ply building	92	88	87	84	85	80	76	68



Intensity of upper octave noise decreases with distance, but the median industrial level remains relatively constant.

parted to the receiving or sensitizing organ such as the ear or a microphone by means of fluctuating or alternating air pressures known as sound waves. The intensity of these sound waves is measured by the hearing organ or the microphone, and the sensations are converted to a proportionate signal. The ear, of course, transmits this signal to the brain. In a microphone, the signal is an electrical impulse that is first amplified and then used to excite a meter marked in "decibels."

### How We Measure Sound

The "decibel" (db.) is a unit used in the sound industry to indicate *relative* sound levels. By definition, the decibel is  $10 \log_{10} (W_2/W_1)$ , where  $W_1$  and  $W_2$  are "power." Since power is directly proportional to the square of pressure level, this expression can be converted to  $10 \log_{10} (P_2/P_1)^2$  or  $20 \log_{10} (P_2/P_1)$ .

As we said before, and as you may see from these equations, decibels are relative and therefore  $P_1$  must be defined in terms of some standard, before values of  $P_2$  can be established. This is an important point to remember since there are several reference standards, and unless the reference is stated, the values of  $P_2$  are practically useless.

The reference most often used in industrial sound measurement is that adopted by the American Standards Assn., which defines the reference sound pressure as 0.0002 dynes/sq. cm. Any sound pressure given in decibels and referred to this value is called "sound pressure level."

It is interesting to note that this 0.0002 dyne/sq. cm. reference level (zero decibels) is close to the human threshold of hearing for pure tones and that "1 dyne/sq. cm." corresponds to 74 db. or about the average level of conversational speech at 3-4 ft.

After many years of study, we have learned that no single number read on a meter can accurately ex-

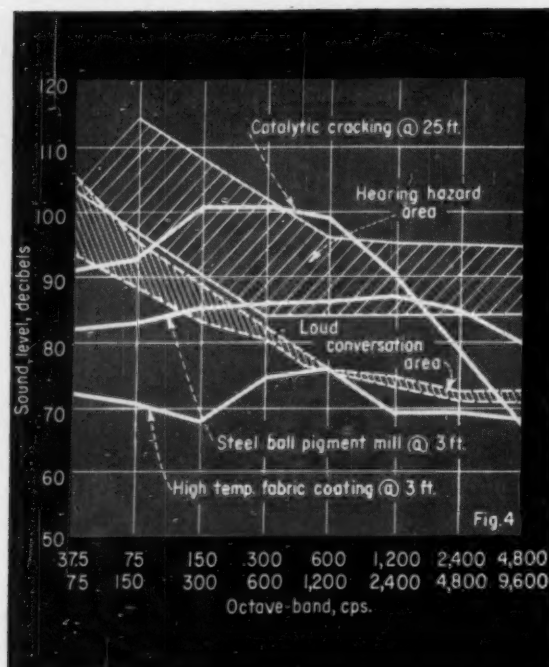
press loudness, annoyance, hazard or speech-interference potential. None correlate with sound-pressure level exactly—although over the normal hearing range (before pain), loudness can be said to double with each 10 db. increase in pressure level.

In measuring noise, then, not only must the overall or total db. rating be determined and stated relative to some reference standard, but we must make and note a number of other determinations. Thus, as we will see later, the distribution of total sound energy with frequency is very important and should nearly always be determined. Total sound measurements are usually made in continuous frequency intervals called "octave bands." It takes eight of these bands to cover the normally encountered frequency range of about 30-10,000 cycles/sec.

### Accurate Measurements Are Difficult

Sound measurements are not easily made and significant errors can be sustained unless work is done by experienced sound personnel, and care is taken to allow for surrounding interferences. Where there are reflecting surfaces, the sound energy of the source may be reflected in such a way that a number of direct and reflected waves passing in opposite directions and out of phase with one another at the microphone position can add or cancel one another, thus yielding false measurements. There is also the effect of background noise although this is often small.

Noise in industry is produced in a variety of ways. An internal combustion engine exhaust, for instance, generates sound waves directly in the air. The much more common source, however, is vibration or impact of solid objects or surfaces as they are struck by hammerlike forces that may be part of a machine, as in a hammer-mill, or an auxiliary to the process, as occurs with a water or steam hammer. Sound generation also



Noise levels in the chemical industries can often be a serious hearing hazard and a detriment to normal conversation.

results from friction on belts or wheels, gear grinding, etc.

All of these noise sources occur in the chemical industry. The noise in a catalytic cracker, for example, is caused by air and small mesh particles that are blown at very high speed through partly closed valves and around corners in steel conduit or ducts, both of which are superb noise radiators.

The important sound range in industry is 40-120 db. of over-all sound pressure level. We have also found that the noises in the middle of the audible frequency range, i.e. 600 to 4,800 cps., are more annoying and hazardous than those at the lower or higher ends of the spectrum. For this reason, the over-all or average sound pressure level is sometimes taken as the average of three measurements taken in the 600-1,200, 1,200-2,400 and 2,400-4,800 cps. frequency bands.

### Chemical Industry Not the Noisiest

In general, the noise surveys that have been made of American industrial installation show that noise levels in the chemical industry are not particularly intense and are, on the average, less than those encountered in many other branches of industry. This is shown by reference to Fig. 1, wherein the sound levels in various industries are compared.

In Fig. 1, middle of each range represents the average of levels in the 600-1,200, 1,200-2,400 and 2,400-4,800 cps. octave bands both for machines (i.e. 3 ft. from source) and areas (20-50 ft. from source). The shaded range of 6 db. above and below the average in-

cludes half the measurements in each industry, although a few had a slightly smaller or greater range. Apparel and leather industries have lowest noise levels, aircraft and primary metals have the highest. Chemicals are near the middle.

Fig. 1, of course, represents average levels. Within this average framework, there are wide variations for each industry. Tables I and II show some typical measurements of a more specific nature for the chemical industry. These tabulations give, respectively, the levels at close range (i.e. within 3 ft. of the source) and "nearby" range (i.e. 20-50 ft. from the source). Combining these and other data, charts of Figs. 2 and 3 are constructed. On these figures, the two cross-hatched areas include 50% of all measurements. The upper and lower shaded areas show upper and lower quartiles. The median is indicated by the full line.

### Is Noise a Hazard?

Another interesting chart comparison is made in Fig. 4. In this figure, we show the relationship of these particular noise conditions in the chemical industry to criteria for hearing hazard and loud factory conversation at 3 ft.

Continuous exposure to the catalytic cracking situation is indicated as quite likely to be hazardous to hearing. Exposure to steel-ball pigment-mill noise, on the other hand, does not seem to be hazardous to hearing, but loud conversation may be difficult, with factory safety thus put in jeopardy. Noise conditions in the region near the fabric-coating operation seem neither to endanger hearing nor hinder important conversation.

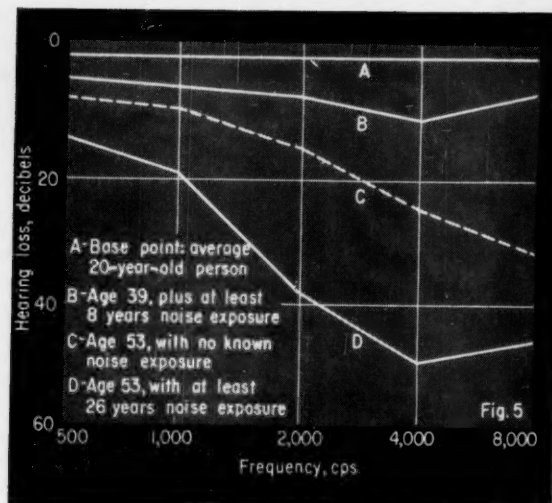
You must remember in looking at this chart, however, that the criteria curves for hearing hazard and conversation hindrance represent general ranges. There is as yet no definite agreement on where the true values should lie. Thus, with reference to hearing hazard, the length of exposure is as important as the level of intensity.

The most important consideration with respect to noise level is its effect on hearing. The ASA Subcommittee Z24-X2 has been studying the problem of "permissible, objectionable and injurious noise levels" since '53. Its first report, titled "Relations of Hearing Loss to Noise Exposure" was published in '54.

We do not know conclusively that exposure to noise causes abnormal hearing loss. All that we can say is that the excess hearing loss measured for a group exposed to noise over a prolonged period vs. the loss in a group not so exposed cannot be explained in any other way.

Another extremely important factor is that it is the combined effect known as "noise exposure" that is the cause, rather than just the decibel rating alone. Equally as important as decibel level are: (1) length of exposure; (2) type of exposure; and (3) type of noise. A noise in itself cannot be rated as hazardous. Also, some people are apparently quite susceptible to noise exposure while others are not.





Noise as a cause of hearing loss has not been proven, but these curves seem to show that there is some correlation.

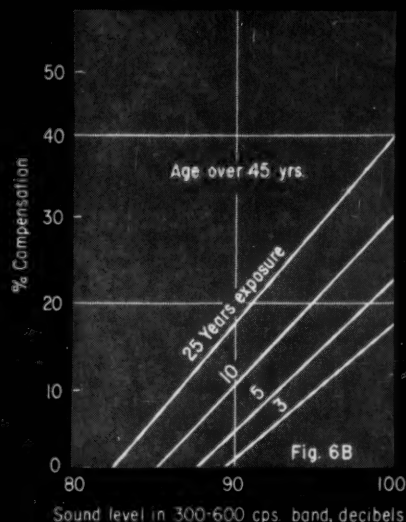
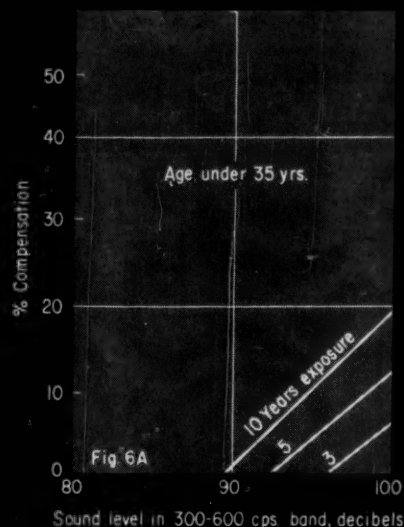
Much of the hearing loss that can be restored by modern-day surgery occurs in the middle ear, but the physician can do nothing to restore damage in the inner ear. Unfortunately, it is damage to this inner ear mechanism that results from noise exposure. The small nerve endings that send electrical impulses to the brain are actually destroyed (burned up, if you will) by the energy of the noise exposure. Since this is apparently the identical action that occurs with age, it is quite difficult to establish whether a given loss is due to age or to abnormal noise exposure, and it is almost impossible to say, for a given individual, how much is due to each.

### Hearing Loss Is Permanent

We can, therefore, only deal with groups and averages. We do know, however, that there are definite differences between the hearing loss of groups known to have been subjected to prolonged noise exposure and those who have not been so exposed, with the loss of hearing of the former group much greater (see Fig. 5). And we also know that the loss is permanent, that medical science is powerless to help, once the loss is incurred. This is sufficient incentive to learn what conditions are harmful and to take remedial action.

Recent work has uncovered a most important factor in detecting noise exposure effects before loss of speech hearing ability results. This factor is indicated in Fig. 5, which shows that hearing loss is greater in the higher frequencies and that a "notch" develops at about 4,000 cps. in the audiometry curve that is typical of noise exposure effects. Even for an 8 yr. exposure, the shape of the curve is the same and the notch at 4,000 cps. is readily discernible.

The answer to industry's safeguarding against noise exposure thus lies in repeat audiometry on groups of

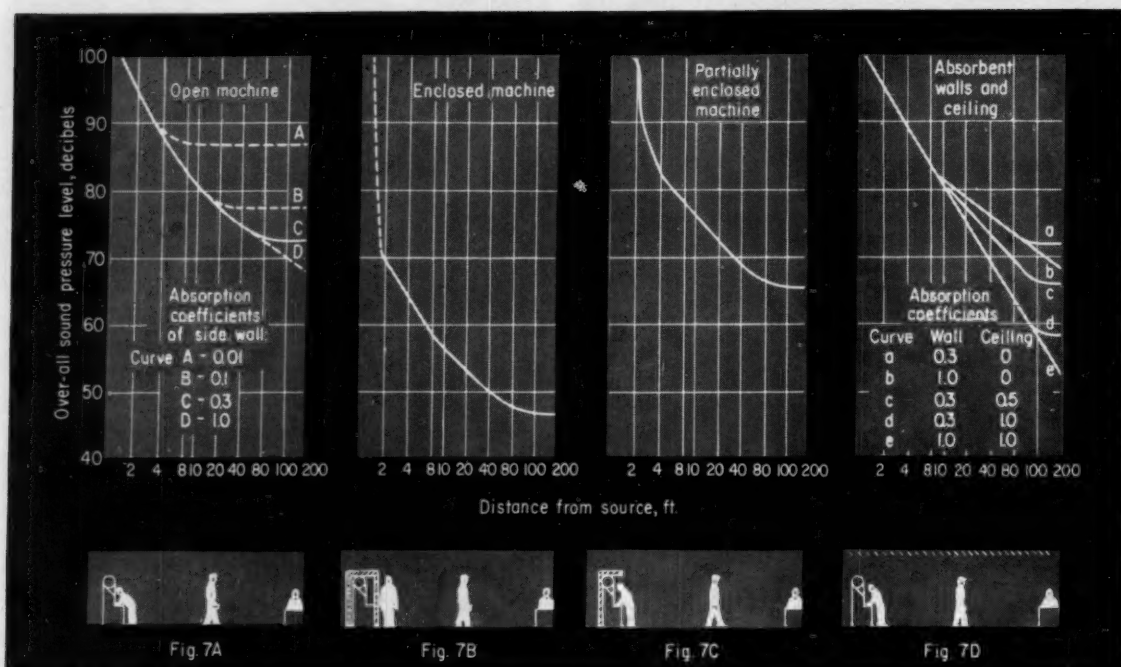


Older people seem to be more susceptible to loss of hearing from continued exposure to loud noise, as these curves show.

### When noise becomes a nuisance—Table III

Octave Band, Cycles/Sec.	Noise Level, Decibels	
	Loud Conversation Indistinguishable	Annoying to Neighborhood
37.5 to 75	95 decibels	79 decibels
75 to 150	89	72
150 to 300	84	66
300 to 600	81	60
600 to 1,200	77	53
1,200 to 2,400	74	47
2,400 to 4,800	73	40
4,800 to 9,600	72	37





Sound levels in the immediate vicinity of a machine and at a distance can be greatly modified by proper choice of enclosures, baffling and surface treatment. In most instances, absorbent walls and ceiling will give best results.

individuals. By periodically sampling the hearing of noise-exposed employees, changes can be observed. Since the effects appear first at frequencies above 2,000 cps., and the speech frequencies are mostly below 2,000 cps., the employees can be spotted and protected before any loss of speech hearing has occurred.

A Wisconsin medical committee has recommended a set of relationships that can form the basis for decision on how much hearing loss can be considered a handicap—and thus compensable. These are shown in Fig. 6. The abscissa for these figures is the sound pressure level for the 300-600 cps. frequency band, since tests have shown that the amount of hearing loss from frequencies in the normal voice frequency ranges (i.e., below 2,000 cps.) correlated best with this band.

The ordinate shows the compensation that would be expected to accrue for 20% of the employees involved, after various periods of exposure to a range of 80-100 db. of sound pressure level in this 300-600 cps. octave. If the noise level is kept below the decibel value corresponding to "0% compensation," then all except the very susceptible employees would be protected.

Even if the intensity of the loudness, or the length of exposure, is not so great as to cause permanent hearing loss, it may still be detrimental from the standpoint of interfering with conversation or with hearing of safety alarms. Table III shows the sound pressure level profile, with frequency below which several investigators recommend that factory noise be kept in order not to cause this undesirable interference.

"Annoyance" noise is a difficult thing to put a value on since it depends on personal factors. Thus, a noisy cash register may be annoying to a store's customers but may be music to the ears of the proprietor. Also, the noise level that disturbs a residential community of young families that already live in an atmosphere of small children is different from that for elderly, retired people. Nevertheless, as a guide, Table III shows the levels, as measured in the neighborhood proper, above which industrial managements can expect to receive complaints.

#### Methods of Noise Control

We might say that there are four general methods that can be employed to control noise and its effects. These can be classed as: (1) noise reduction at the source, or prevention of the sound being generated at all; (2) enclosure of the source; (3) use of sound absorbent materials; and (4) protection of the hearing mechanism. All of these methods have their advantages and limitations.

The first place to start, of course, is at the source of the noise. By proper design, a machine might be quieted without adding uneconomically to its cost or affecting its performance. Referring to Fig. 7A, if the machine in question generated a sound pressure level only 25 db. lower, i.e. 75 db., the noise problems would be well down within known tolerable limits.

Such action has been taken in a few cases, but this procedure is rare since it invariably requires basic

research on the machine itself to determine the true source of noise generation and methods of reducing it. Then, even if this is done, the redesign and retooling required to alter the unit are nearly always economically prohibitive.

Nevertheless, as industry becomes more and more aware of noise problems and knowledge of how to deal with them grows, attack of the problems at the design stage should become more widespread.

The second method of noise control is used rather widely. It consists of enclosing the source of the noise, either totally or partially. Figs. 7A, B, C and D illustrate this. The bottom portions of these figures show representative broad classes of activity as they might occur at three different distances from the source. The machine operator might be only 2 ft. away; fellow workers might be 20 ft. away; and clerical or desk employees might be at their jobs 200 ft. away.

### Noise Level Depends on Environment

The curves in the upper portion of these four figures show the decibel rating "heard" by these classes of people under various sound control conditions. The shape of the curve will depend upon the absorptive effect of the surrounding surfaces. This absorptive effect, which can be expressed as an absorption coefficient, varies from 0.1 to 1.0. More will be said later about this when discussing the third control method: use of absorptive materials.

For the present, consider the base case of a machine operating unprotected in a room that has virtually no absorption from the floor and ceiling, and an average absorption coefficient on the side walls of 0.3. This condition is represented by the solid curve in Fig. 7A. Here, the operator 2 ft. away is exposed to about 95 db, which, as seen from the previous discussion, is a level that, upon long exposure, will definitely cause hearing damage.

Even at 20 ft. from the source, the level is about 78

db., which is annoying and might even interfere with hearing an alarm. At 200 ft., the desk worker's efficiency is assuredly affected by a noise level of 70-75 db.

Now let's see what can be accomplished in this case with enclosures.

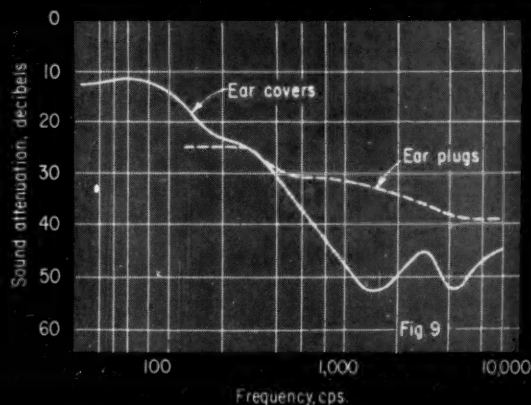
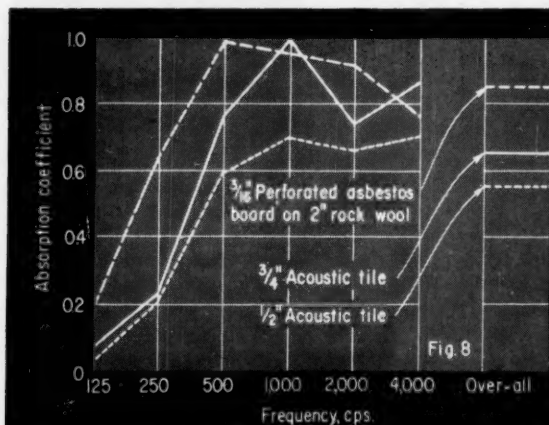
Total enclosure of the source can produce the condition shown in Fig. 7B. This, however, is more difficult to achieve than you might believe. You must remember that the sound level inside such an enclosure will always be higher at a given point than it would be without the enclosure because the sound energy is prevented from propagating away from the machine.

If the inside of the enclosure is essentially non-absorbing or, in other words, if the sound energy is not caught and dissipated by the enclosure wall material, the sound level inside will build up until it is sufficiently high to overcome the transmission loss provided by the walls of the enclosure. An enclosure in itself, then, may reduce the surrounding noise levels by only a very small amount.

### Total Enclosure Is Expensive

To be effective, such enclosures must have massive walls to provide the required transmission loss, and must be made of very good sound absorption materials—nonporous and with openings well sealed to prevent sound from escaping by direct air passages. With such design, the condition of Fig. 7B can be achieved. Here, the noise level inside the enclosure is prevented from rising more than 2-3 db, and the attenuation through the walls is 28 db. This accomplishes a 25-db. reduction throughout the remainder of the plant. Such design, however, can be very costly.

Total enclosure application has one obvious disadvantage in that it cannot be used where an operator runs the machine or where raw materials and finished products must be continually fed to and taken from the machine. In some cases, the enclosure can be en-



Proper use of absorbent surfaces and ear plugs or covers can greatly reduce the apparent noise levels in an area.

larged to include the operator and his working materials. This soon becomes unwieldy, however, and in addition, requires the operator to wear protective ear devices and work in a most undesirable atmosphere where, for instance, he cannot hear alarms or other warning sounds.

Another solution, and the one most often used, is partial enclosure. With such provision, the operator can still be stationed just inside on one open side or, better yet, the opening can be just the minimum necessary to allow entrance and exit of materials and the operator's hands and/or feet.

With partial enclosure, there is a direct air passage and, hence, it is not possible to obtain the large transmission loss obtained with complete enclosure. However, by proper design and orientation, as much as a 15-db. reduction in noise is possible. Fig. 7C illustrates the more normal case of a 5-8-db. attenuation.

A special case of partial enclosure has baffles. These can be very useful in shielding limited areas. If the surfaces are nonabsorbent, noise reduction in one area is achieved only at the expense of increased noise in another. This may be perfectly satisfactory if personnel are not normally in the "loud" areas.

### Use Absorbent Materials

The third method of noise control is the use of sound absorbent materials on the walls and ceilings. The floor is not usually included in such programs since the absorbent materials that must be used are not suitable for abrasive or compressive wear. Reference to Fig. 7A shows how various absorbent materials on the walls alone can affect the sound levels in areas surrounding a noisy source. Fig. 7D carries the program somewhat further by showing the effect of also treating the ceiling surface. It is interesting to note that this type of noise control does not reduce the noise levels near the machine, since the absorbent material can only reduce the energy level of sound waves that have been reflected from its surface. The direct or unreflected energy waves are unaffected.

All of the above curves and ratings are on the basis of "over-all" sound pressure levels. As was explained previously, the sound pressure level is a function of frequency. In Fig. 8, we show curves of the absorption coefficients for three typical acoustical treatments as a function of the frequency in cycles per second for large flat surfaces. The average, or over-all, values corresponding to these treatments are also shown for reference.

The fourth method of noise control is the use of ear protectors. A variety of these are on the market. For industrial use and protection, these definitely have a place. They should, however, always be fitted by a physician since, otherwise, a proper fit will hardly ever be obtained and much of the expected protection will be lost. Limiting their effectiveness: since hearing also occurs by bone conduction they cannot reduce this part of the noise pickup. Also, these devices lessen all sounds, not just the undesirable ones. Thus, conversation is difficult if not impossible when wearing them.

(The attenuation that can be expected to result from well-fitted ear plugs and ear covers is shown in Fig. 9.)

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Meet  
the  
Author



ROBERT L. JACKS, began his professional career as assistant professor of chemical engineering at Louisiana State University and, concurrently, as senior design engineer for Esso Standard Oil Co., at Baton Rouge. In 1954, he joined M. W. Kellogg Co. in New York for whom he is now project manager. In this position, he has been responsible for a wide variety of petrochemical projects.

Mr. Jacks is a chemical engineering graduate of Tulane University and has an M.Sc. from M.I.T. He is a member of Sigma Xi, AIChE, ACS, ASME, president of Alpha Chi Sigma, a licensed P.E. in New York and is listed in Who's Who in Engineering.



## The Pro and Con of . . .

# Multiple-Contract Construction

**Are your construction projects handled best by a single-responsibility contractor or on a lump-sum, multiple-contract basis?**

G. F. McGOVNEY, *Dow Chemical Co., Freeport, Tex.*

We believe that competitively bid, lump-sum, multiple-contract construction in the chemical industry is the most efficient way to complete capital expansion.

In order to get us all off on the same footing in this discussion, the first thing required is a definition of terms. "Competitively bid" is fairly well understood but, in our context, I need to point out that in practice we do not advertise for bids in the open market. Rather, we select from four to six contractors whom we consider qualified to do our work and with whose performance we elect to be satisfied. In this way, when we receive a low bid, that contractor is automatically awarded the job.

"Lump sum" means just what it says. We try to furnish a set of specifications, drawings and defined material to a contractor, and for the completion of that service, we expect to pay him a fixed lump sum of money.

"Multiple contract" means that to complete one project, or in our case one chemical plant, we may resort to more than one contract to finish that job.

To illustrate, we will show an example of a production unit accomplished by a number of contractors on what we consider a multiple-contract basis.

This system has been an evolutionary rather than a revolutionary process at Dow. We have been experimenting with lump-sum competitively bid contracts for a number of years. We don't know that we have come as far as we will go; however, we've taken several years and a good many millions of dollars of plant construction to experiment with this system and recommend it for consideration.

This article is based on two papers presented at a meeting of the American Assn. of Cost Engineers held in Houston in June 1960. Mr. McGovney, of Dow's construction department, stated the case for multiple-contract construction and Mr. McKay, Fluor's manager of estimating, presented a rebuttal. McKay's rebuttal points are inserted in color at appropriate places in McGovney's discussion.

W. I. McKAY, *The Fluor Corp., Ltd., Los Angeles.*

There is one more thing to say by way of introduction: we do not believe that any chemical construction job can be held up as an example for the way all others should be done. We believe that each job must be studied in relation to the ambient conditions in the area and in the plant at that time.

Examples of these conditions are: the amount of construction being done in the area at the time (and by area we mean the whole Texas Gulf Coast); the status of labor negotiations; the season of the year; the load on our engineering, purchasing and construction departments; the amount of time that our management can allow for completion of the project.

At this point, we will explain why we think this is a good method and the reasons that compelled us to experiment and arrive at this way of doing capital construction in the chemical industry.

- We consider that the short time allowed by our management from the request to build a facility to its desired completion requires that we use this method to get the shortest possible building program.

*Mr. McGovney cites speed as the first reason for the desirability of multiple-contract construction. This opinion, however, is contrary to Fluor's experience—we have found that the shorter the schedule, the greater the need for a single contract. Conversely, the more relaxed a schedule, the greater the number of subcontractors that can be used without interference.*

*In the steam-power industry, for example, this converse pattern is particularly evident because prolonged equipment deliveries extend the schedules.*

*On the other hand, short schedules demand more intense integration of various crafts and operations. Chaos, therefore, can only be avoided by guaranteeing the singleness of purpose inherent in a unified contract.*

- We believe that this method offers the best flexibility to allow research and engineering to work in parallel instead of in series while field operations are going on.



## Schedule of contracts, estimated and actual costs for Project X

Contract No.	Description of Work	Designed by	No. of Bidders	Range†	Budget Estimate	Detail Estimate	Actual Bid
<b>Process plant</b>							
1 & 2	Seawater mains & underground elect.	Owner	5	1	100%	72%	83%
3	Warehouse, product	Contractor	1	3	100%	68%*	68%
4	Office buildings	Contractor	4	2	100%	69%	72%
5	Warehouse foundation, parts	Owner	7	1	100%	114%	74%
6	Parts warehouse building	Owner & Contr.	1	1	100%	108%	94%
7	Process building	Owner & Contr.	1	2	100%	104%	97%
8	Compressor buildings (2)	Owner & Contr.	1	2	100%	94%	57%
9	General plant foundations	Owner	2	3	100%	89%	105%
10	General mechanical	Owner	5	4	100%	64%	53%
<b>Raw material feed plant</b>							
1	Compressor bld'g. extension	Contractor	2	1	100%	103%*	103%
2	Foundation, general	Owner	8	1	100%	69%	45%
3	General mechanical	Owner	9	3	100%	40%	28%
<b>Services</b>							
1	Road & site development	Owner	3	2	100%	86%	75%
2	Piping services	Owner	8	2	100%	69%	52%
3	Electrical services	Owner	4	1	100%	85%	54%
4	Seawater pump station	Owner	6	1	100%	78%*	78%
5	Air compressor station	Owner	6	1	100%	64%	52%
<b>Total for Project X</b>			<b>21</b>	<b>5</b>	<b>100%</b>	<b>66%</b>	<b>57%</b>

† Range 1—less than \$50,000; Range 2—\$50,000 to 200,000; Range 3—\$200,000 to 500,000; Range 4—\$500,000 to 2,000,000; Range 5—above \$2,000,000.  
\* No detail estimate.

*I have no argument with Mr. McGovney's view on coordination of research and engineering, but I think such coordination is possible with any kind of contract or multiple thereof. More likely reasons for difficulty in meshing the two are tight project schedules and the competence of the people responsible for research and for engineering, not the modus operandi.*

• We think that this system allows us to take advantage of contractor specialties within the trade area. To define this a little more, we feel that this system allows us to get building specialists to bid on our foundations, earth-moving specialists to bid on our earthworks, etc.

*Fluor also takes advantage of contractor specialties when it can subcontract specialized work without upsetting or interfering with the progress of a job.*

• We feel that this is the best way to afford a dependable definition of expenditures before the final capital commitment to a contractor for construction.

*As for dependable definition of expenditure, Fluor is prepared to quote a firm price on any job in its field anywhere in the free world. It can do this before engineering money is spent and before commitments are made for materials. This type of single-responsibility contract affords the best dependable definition of project expenditure.*

• We believe that this system best answers our need to allow contractors enough job definition to insure planning. By planning, we mean planning in manpower utilization, union labor relations, new tech-

nology and the best use of construction equipment.

*Mr. McGovney's last point is on the insurance of planning. Any system of operating and any type of contract requires planning. If an operating company has enough continuity of work to carry skilled construction planners on its payroll, that is splendid. Major contractors have to have such personnel and, due to continuous workload, they are most sensitively attuned to ambient conditions in the industry.*

I'd like to stress the new technology angle a little. It has been our experience that contractors are a great deal like we are as owners—their new technology is mothered by necessity. We do a lot of things at our plant, as I'm sure you do, as our fathers did, because they have been handed down to us. We've learned many tricks by watching contractors, who had learned new technology at another area, translate these practices into our plants to a mutual advantage.

For our example, we will discuss "Project X" which is an actual project installed at the Texas Division of the Dow Chemical Co.

Project X was authorized by our board of directors on Oct. 1, 1957. Prior to authorization, there had been a series of meetings and discussions by what we call a planning team. Our planning team is made up of one representative from each of process, engineering, construction, purchasing and control sections, each of whom has authority to speak for and bind his department to commitments and schedules.

So, prior to authorization by our board for the job to be engineered, the planning team had met four or five times and had settled a tentative schedule for the process department to turn over their information to engineering; for the engineering department to turn over order bills to the purchasing department for pur-

chase of the long-delivery material; and for the construction department to build the job.

In addition, the planning team had discussed and agreed on the number, types and contents of the contracts that would be used for this job. This contract breakdown is shown in the schedule exhibit. It was agreed that Plant X would be built in ten incremental contracts; that the raw-material feed plant to supply Plant X would be built in three contracts; and that the general facilities to serve both Plant X and the feed plant would be built in four contracts.

I'd like to stress here again that we can give no universal reason why there should be 10 contracts for Plant X. In fact, if we had Plant X to schedule again, I would expect the number of contracts would change, more or less, and the content would vary.

I'll explain a bit of our thinking to show why we selected the contract split that we did.

The general service contract—the roads and site development—was obviously the first thing required.

The next contracts required were the underground work in the plant and those we also scheduled early.

The office buildings were generally of the "commercial" building type, and in our planning we put them in a separate contract.

The process building and the product-storage warehouse were "tilt up" concrete specialty buildings. We treated them as "design, fabricate and erect" contracts.

The two compressor buildings and the parts warehouse we bought already erected, as standard buildings from fabricators in the Houston area. These are what are commonly called "off the shelf" buildings.

The general plant foundations we let as a separate contract.

Down to this point, there were many splits in the contracts planned to complete the plant and they were designed for two things: first, to allow the contractors to begin construction at the earliest possible moment; second, to give our engineering department

additional time (in this case, seven months) to work on the general mechanical work of the plant while all other construction and shop fabrication was proceeding. By this plan, we expected that the plant would be built as rapidly as possible and that our engineering department would have an adequate period in which to work on the mechanical drawings. Consequently, we hoped that they would turn out a set that would have few changes and would be accurate and easy to bid. Such proved to be the case.

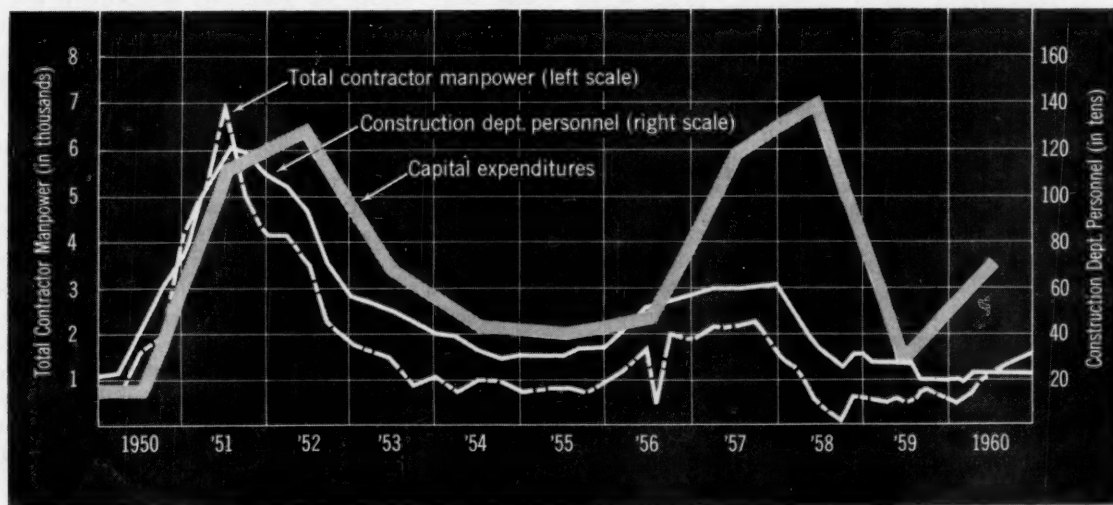
The rest of the contracts for the raw-material feed plant and the general services were not difficult to schedule because we could allow for the same two things. We could give our engineering department time to work on them and still have time for the contractor to finish them easily.

In these service contracts, it is interesting to note the reasons the splits were made the way they were. It is obvious that Contract No. 1, the roads and site development, had to be independent so that it could be bid and completed early. The piping services and the electrical services were split because they are done by different types of contractors. That is, we tried to take advantage of contractor trade specialties.

The sea water pump station was separate from the piping services by an accident of geography. The locations were separate, so we separated the jobs.

Another thing settled by the planning team, before authorization, was a definition of the owner-furnished material and the delivery dates required. Owner-furnished material, in our definition, is simply material that a contractor cannot be expected to furnish and still complete the project in the scheduled time. Defining this material beforehand gave our engineering department a target date for turning out the bills.

The other function of the planning team in this project was to pass along the information on which the team had agreed to the sections represented. Also, whenever any department was unable to meet the



schedule, its representative was responsible for reconvening the team and rescheduling, and for explaining the rescheduling.

As far as the construction department was concerned, all of the information compiled by the planning team was made into three manuals (which made one large volume): one for the general office; one for the superintendent of construction; and one for the field engineer in charge of the project. The field engineer was instructed that contractors and contracts had to comply with the schedule set by the planning team or that he had to convene the team and explain why the schedule could not be met.

Now, let's examine the results of all this planning. Comparison of the planned schedule with the actual schedule after completion of the project showed that performance and time, for most of the contracts, were very close to those scheduled as much as a year earlier. A comparison of the original estimates, actual estimates and the bids that were received is shown in the table. Also shown is the number of contractors who were invited to bid on each job.

*Schedule is discussed in terms of management's demand for soonest possible plant completion. By Fluor's standards, the schedule described is luxuriant. It is my understanding that Project X was in the \$8-\$10 million range and according to Mr. McGovney, it required about 18 months to complete. Concurrent with the Project X schedule, Fluor recently completed engineering, procurement and construction of a grass-roots plant of comparable value for the government in a remote area in just nine months. Fluor also completed a \$14-million catalytic cracker in 11½ months. These schedules would have been impossible with 17 subcontractors scurrying around the the jobsite.*

To forestall the obvious objection of "handpicking" one project from among the many in order to prove our point of view, we have prepared the graph showing a composite record of construction at the Texas Div. for an 11-year period.

Note the periods 1951-52 and 1957-58, during both of which we accomplished approximately the same dollar volume of capital construction. During 1951-52, we employed single-contractor, cost-plus contracts to complete our expansion. During 1957-58, we employed lump-sum, multiple-contractor contracts. As you can see, contractor manpower was less than one half as great during the latter period. It is our belief that the planning and execution inherent in our lump-sum, competitively bid, multicontract approach is the major contributing factor in this significant improvement.

*The curve Mr. McGovney includes contrasts manpower with capital expenditures. The area of the curve that illustrates poorest performance is described as "single-contractor, cost-plus contracts." But that area coin-*

*cides with the Korean War, a time when we know that labor efficiency was at a national low. There has been a steady increase in labor productivity ever since.*

*By way of example, Fluor has had three lump-sum projects located in the same city on the Gulf Coast, during the past six years. All three were built by the same field superintendent, and all were in the same price bracket as Project X. Project A was completed in 1955. Project B was completed in 1958 at a labor unit cost 14% below that of Project A and Project C was completed in 1959 at a labor unit cost of 24% below that of Project A. Such improvement in labor efficiency has been experienced by most contractors. That the lump-sum multiple-contract era happened to coincide with this improvement is interesting—but misleading. Improvement in labor efficiency was due to many things: material deliveries got better; there wasn't a shortage of skilled people; labor was more cooperative.*

*In the table, the underrun for estimated versus actual costs indicates that the estimators probably lagged improvements in labor efficiency. The detailed estimate was under-run by 14%. Allowing for the stabilizing effect of material and contractors' shrinking profits, this reflects about the same sort of productivity gain as in the example above.*

When applying this system, remember that each job must be studied in the light of its own peculiar circumstances. The factors that influenced us were: time; flexibility; utilization of contractor specialties; dependable definition of costs; and last, but certainly not least, the planning, both by Dow and the contractors, which inevitably resulted.

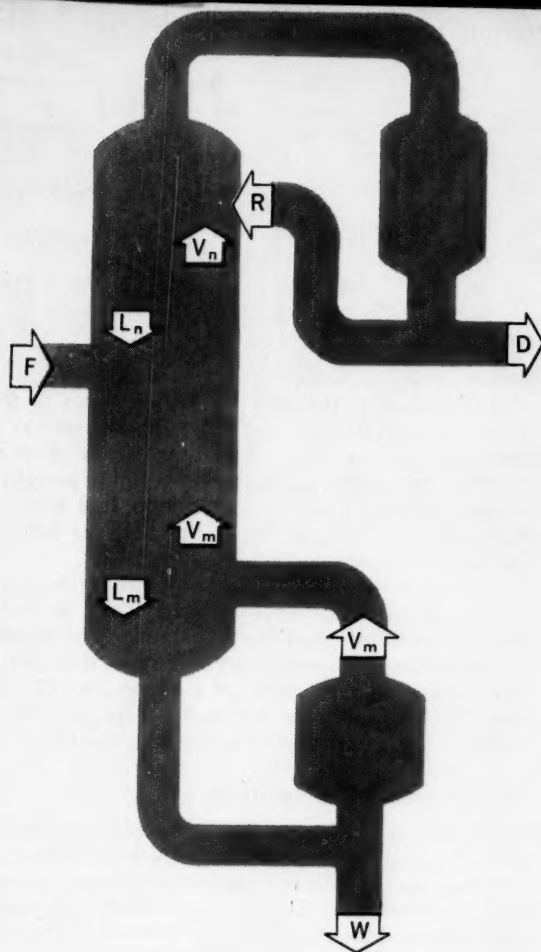
We are of the opinion that the figures and schedules presented are representative of the savings that can be made in this field by hard work, planning and good performance on the part of the owner and the contractors. It is also our belief that contractors will make more money on lump-sum competitive bids, closely defined and planned, than can be made on what are called force-account or agency type contracts.

As stated before, these are our opinions and we think we have adequate ground for them.

*I would like to close with a few points of my own:*

- 1. To attain the shortest possible schedule, you must have a single-responsibility contract and integrated engineering and construction.*
- 2. Earliest possible firm definition of project cost results from fixed-price bids on total integrated engineering and construction jobs.*
- 3. Where it is desirable for the owner to do the engineering for protection of proprietary know-how, the integrated construction job with a single-responsibility contract will provide the shortest schedule.*





## Controlling Distillation Columns

Distillation exists to deliver pure product. This guide to dynamics and instrumentation shows how proper control will help you get it.

L. BERTRAND and J. B. JONES  
E. I. du Pont de Nemours & Co.

Purification of materials by distillation is a prominent operation of many, if not most, chemical processes today. And control of distillation is important to meeting the purification requirements continuously.

Reference will be made in this article to composition control, temperature control, pressure control, level control, etc., but all of these are elements of a control system designed to maintain purity of product. To be sure, some controls regulate productivity and economy, but it would be difficult to suggest an example where composition of product is made subordinate to either.

The more elusive aspects of distillation control relate to control of product composition and its responses to disturbances—feed rate, feed composition or feed enthalpy—that originate outside the column. Although the McCabe-Thiele diagram was devised originally as an aid in design, it is helpful, too, in visualizing the effects of disturbances, several of which will be shown later on.

### Degrees of Freedom for Control

It is important to recognize the degrees of freedom of choice in specifying the variables to be controlled. The choice that is open is the natural consequence of the column heat and material balances. It is analyzed from the typical distillation column shown at the left on this page.

The over-all material balance can be represented by the following two equations:

$$F = W + D \quad (1)$$

$$F x_F = W x_W + D x_D \quad (2)$$

where  $F$  is feed rate,  $W$  is bottom product,  $D$  is distillate, all in lb. mol/unit of time, and the  $x$ 's refer to mol fraction of the low boiler in the three streams identified by subscript.

It's assumed that molar heat capacities and latent heats of vaporization of all components are the same. It is assumed also that heat losses from the column are negligible, and heats of mixing are negligible. The upward vapor flow and downward liquid flow, therefore, in both rectifying and stripping sections are invariant. Accounting for the column heat balance is independent of the compositions of the product streams.

With these qualifications, the internal material balance and the heat balance can be handled by the following six equations:

$$L_n = (1 + b) R \quad (3)$$

$$V_n = D + (1 + b) R \quad (4)$$

$$L_m = L_n + qF \quad (5)$$

$$V_m = L_m - W \quad (6)$$

$$x_W = f(L_m/V_m) \quad (7)$$

$$x_D = g(L_n/V_n) \quad (8)$$

where  $V$  is vapor rate and  $L$  is liquid rate in rectifying section (subscript  $n$ ) and stripping section (subscript  $m$ ), lb. mol/unit of time. Distillate rate  $D$  and external reflux  $R$  are stated in same units. The numerical factor  $b$  in Eqs. (3) and (4) depends on reflux enthalpy or temperature, and it is greater than zero when reflux temperature is below that at the top of the column.



# Possible modes of distillation column control

Distillate and Feed	Distillate and Bottoms	Distillate and Boilup	Distillate, Bottoms and Boilup	Bottoms and Boilup	Bottoms, Boilup and Reflux	Feed Rate, Distillate and Boilup	Distillate, Bottoms and Boilup	Distillate, Bottoms and Feed Enthalpy
<b>Free variables</b>	$x_F, q, b$	$x_F, q, b$	$x_F, b$	$x_F, q, b$	$x_F, b$	$x_F, b$	$F, x_F, b$	$x_F, b$
<b>Specified variables</b>	$F, x_D$	$x_D, x_W$	$x_D, V_m$	$x_D, x_W, V_m$	$x_W, V_m$	$x_D, F, V_m$	$x_D, x_W, V_m$	$x_D, x_W, q$
<b>Dependent variables</b>	$W, D, R, V_m, L_m, V_n, L_n, x_W$	$W, D, R, V_m, L_m, V_n, L_n, F$	$W, D, R, L_m, V_n, L_n, F, q$	$W, D, R, L_m, V_n, L_n, x_D, F$	$W, D, L_m, V_n, x_D, F, q$	$W, D, R, L_m, V_n, L_n, q$	$W, D, R, L_m, V_n, L_n, q$	$W, D, R, L_m, V_n, V_n, L_n, F$

The numerical factor  $q$  in Eq. (5) depends on feed enthalpy, and it satisfies the following constraints:

- When feed temperature is below that of feed plate,

$$q > 1$$

- When feed temperature and composition are identical to those of the feed plate,

$$q = 1$$

- When feed enters column partially vaporized,

$$1 > q > 0$$

- When feed is completely vaporized and at saturated temperature,

$$q = 0$$

- When feed is superheated vapor,

$$q < 0$$

In Eqs. (7) and (8),  $f$  and  $g$  account for functional relationships that are dependent on column design factors such as number of plates in the column, location of control plates, location of feed plate, and temperature or other criteria specified for control plates.

From the standpoint of controls, these factors are fixed. The automatic controls, for example, are unable to shift the injection of feed up or down the column in response to departures from optimum column operation. Neither is location of the control plates ordinarily regarded as variable.

Even the control plate temperatures are usually considered fixed, although it would be possible to regard them as variable, and arrange feedback controls for their regulation. The consequence of fixing all the factors on which the functionals  $f$  and  $g$  depend is to fix the functionals, in turn. They will, therefore, be excluded from the list of variables in the analysis that follows.

Excluding the functions  $f$  and  $g$ , Eqs. (1) through (8) include 13 variables. One possible classification of the 13 is:

*Free variables (usually not controllable)*— $x_F, q, b$

*Variables whose values are usually controlled*— $F$  and  $x_D$ , or, alternatively,  $F$  and  $x_W$

*Dependent variables*— $W, D, V_n, V_m, L_n, L_m$ , and  $x_W$  or, alternatively,  $x_D$

Five of the 13 variables—the free and controlled ones—are defined, which leaves eight unknowns in eight independent equations. There exists a unique solution for this set, and the column performance is thus completely determined.

It is necessary, therefore, to assign values to five of the 13 variables in order to reduce the system to eight equations in eight unknowns. Usually, some of the five represent conditions imposed by preceding process steps, such as feed composition, feed rate and feed enthalpy. Usually the overhead or the bottoms composition is specified.

It is not permissible to overdefine the system; that is, the sum of free and controlled variables, as designated above, must equal five. Conversely, the dependent variables must equal eight. Within this framework, there are a number of possible combinations open that characterize different modes of column control. Several of these are shown in the table.

## Measurement of Composition

Distillation is invariably concerned with composition control, either of the distillate or bottom product or, at times, both. Because composition bears an unvarying relationship to boiling temperature (assuming fixed pressure), it is natural that product composition is usually controlled via temperature.

The actual boiling temperature at the temperature control point will change with changes in column pressure. This can be troublesome, particularly in low-pressure columns where minor variations in absolute pressure are substantial compared with the operating pressure.

A differential-vapor-pressure-type temperature-measuring system (known as "dV" transmitter) avoids this problem. In this device, to one of two opposing bellows is connected a thermometer bulb filled with liquid of the composition desired at the sensing point in the column. When subjected to column temperature, this bulb develops an internal pressure dependent upon temperature and the composition of liquid in the bulb.

Simultaneously, the liquid in the column exerts a pressure dependent upon the temperature and the liquid in the column. Since bulb and column contents are at the same temperature, the pressures exerted in the column and in the bulb are each a function of their respective liquid composition in the bulb and in the column. Comparing the two pressures in the differential force-balance system of the device affords a sensitive index of composition in the column, as referred to the fixed composition in the bulb, which is independent of minor variations in absolute operating pressure.

Most of the individual control loops discussed and illustrated on pp. 141-142 are of standard design and

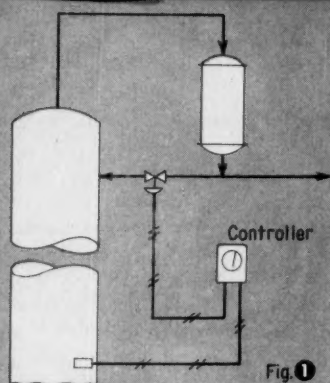


Fig. 1

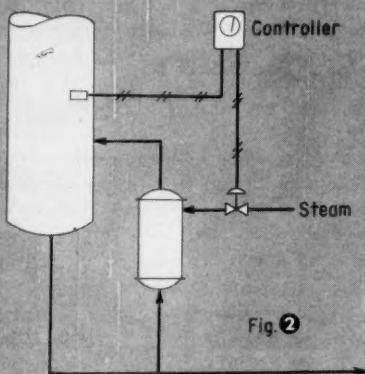


Fig. 2

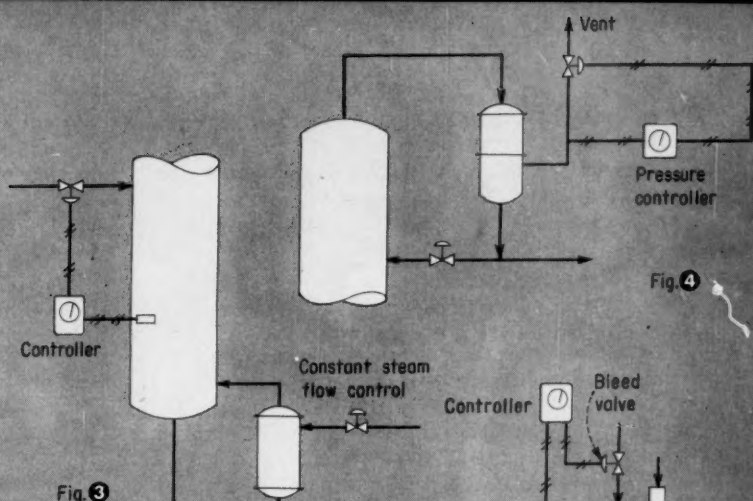


Fig. 3

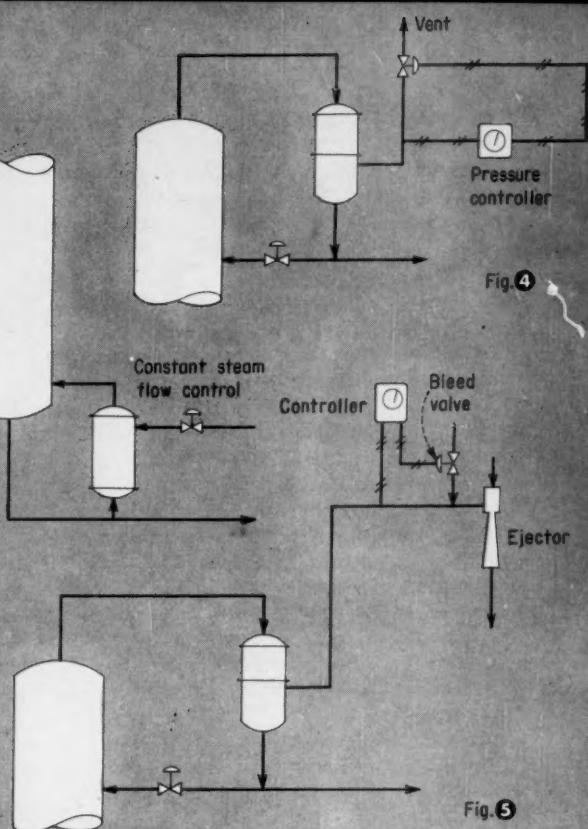


Fig. 4

Fig. 5

## Composition and pressure controls

The following discussion is based on use of temperature to indicate the composition of material, but the techniques described apply equally well to control loops based on other composition measurement methods. Regulation of product composition is normally accomplished by manipulating boilup and reflux rates, which changes the relative rates of vapor and liquid flow throughout the column.

Figs. 1-3 show only those controls that affect product composition. In Fig. 1, distillate composition, as measured by a temperature element in the column, is controlled by regulation of reflux. Similarly, in Figs. 2 and 3, the bottoms composition is controlled by regulation of either boilup in the former, or feed rate in the latter.

It might appear advantageous to maintain both reflux and boilup on automatic control. This presents no problem if a simple binary separation is being controlled; but rarely is this the case. If the feed contains an impurity with a volatility between those of the distillate and bottoms, automatic control of both reflux and boilup presents problems. The reflux control operates to return the impurity down the column, while the boilup control operates to send the impurity up the column. The result is that the intermediate boiler accumulates in midcolumn and displaces the composition to such an extent that separation fails.

It is possible to devise controls, either continuous or intermittent, to sense midcolumn temperature and purge the accumulated impurity (the so-called "Pasteurization column"). Unless the accumulation is minor, however, it would be uneconomical to discard the purge without redistillation. An alternative is to allow the intermediate boiler to be discharged with either bottoms or distillate and provide an additional column for its separation, if justified. The final choice rests on a comparison of the economics of the methods.

Although based upon consideration of binary mixtures contaminated with intermediate boiling impurities, these

remarks apply equally to separation of key components from multicomponent mixtures.

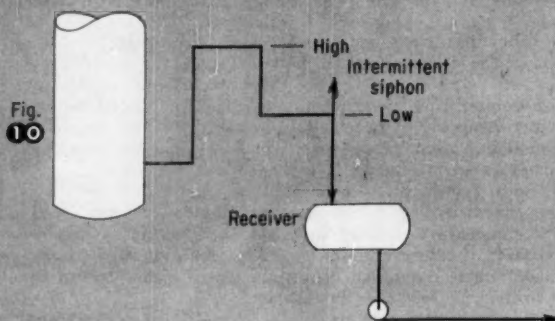
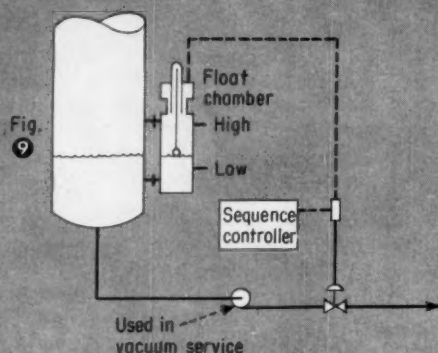
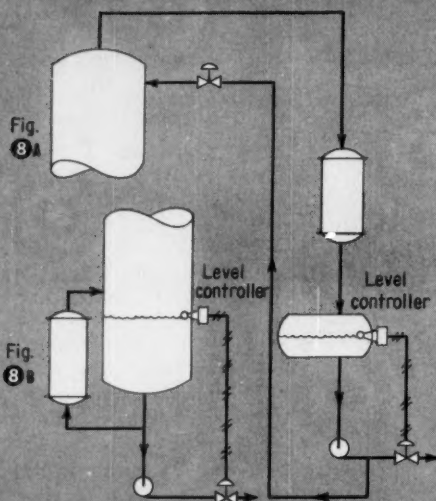
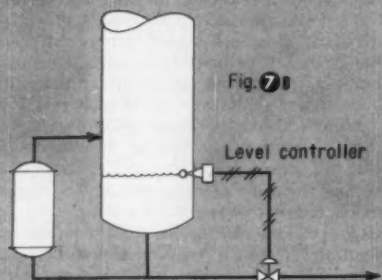
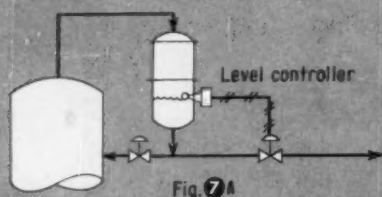
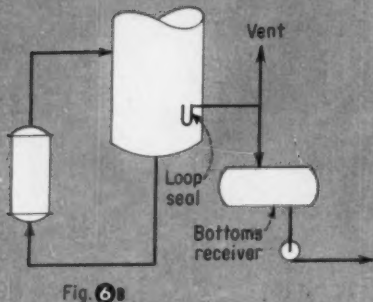
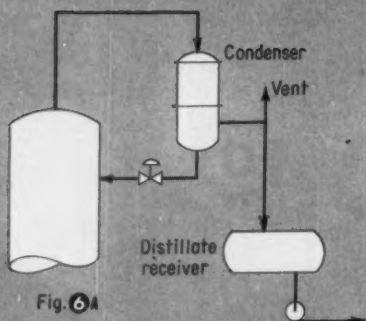
Common to both distillate and bottoms temperature controllers is that the pertinent temperature measurement is made in the column a number of plates away from the product itself. Usually a product stream that is relatively pure is being separated from the binary mixture, so that boiling point or any other quality test of the product is often insensitive to changes in its concentration.

Location of the temperature-sensing element a number of plates away makes it possible to obtain a greater change in temperature for a fixed change in final composition. Fixing the composition at such a point in the column suffices to control the column product composition within narrow limits, even with wide variations in other factors such as vapor and liquid flows.

Selection of the optimum location for the sensing element can best be based on the column temperature profile (temperature vs. plate number), which the distillation designer should provide. The element should be located where the temperature profile is steep, but not too far removed from the end of the column. The rectifying-section temperature-measuring element must be above the feed plate, the stripping sections element below it.

Distillation systems invariably are designed for uniform pressure operation, ranging from low-vacuum through atmospheric to very-high pressures. Atmospheric pressure usually presents no problem to the control system designer. Exposure to atmospheric contamination, however, may not be permissible; if so, a modification of vacuum control can be used with a positive bleed-in of a suitable inert gas.

Fig. 4 shows a typical pressure control system for a distillation column. Here, control is obtained by regulation of the amount of venting on the condenser. Fig. 5 shows a vacuum control system, with control based on the use of a vacuum-tempering valve ahead of vacuum source.



## Inventory control

Distillation columns provide little or no surge capacity, so it's necessary to remove the distillate and bottoms as fast as they accumulate. Controls for product drawoff should be no more complicated than absolutely necessary. In columns operating at atmospheric pressure, loop-sealed overflows may be all that is required. At positive pressures, level-controlled letdown valves are suitable. For vacuum operation, discharge pumps in combination with liquid-level-controlled valves are required.

Figs. 6-8 suggest various means of obtaining column inventory control. Figs. 6a and 6b show systems for columns operating at atmospheric pressure with inventory control by loop-sealed overflows on distillate and bottoms respectively. Figs. 7a and 7b show a system for columns under positive pressure, where liquid-level controllers are used. Fig. 8a also represents refinery practice for inventory control under pressure. And Figs. 8a and 8b are the typical system for a column under vacuum.

Where the feed composition is very low or very high in low boiler content (i.e., when  $x_2$  approaches 1.0 or 0), controlling the flow of the minor product stream can be difficult because of low rates of flow. In such cases, a high-low level-control system can be used, allowing the product to accumulate in a receiver until the upper limit of level is reached. Then the system opens a valve fully, to discharge until the lower limit of level is reached.

For pressure or vacuum operation, Fig. 9 shows a typical control system employing a float switch with magnetic pickup to sense the high and low level points and to actuate the discharge valve electrically through a solenoid valve on the air-to-valve line. Note that in the case of vacuum operation, where a discharge pump is used, a sequence controller is used to start pump, open valve, close valve and stop pump. Fig. 10 shows the use of an intermittent siphon to accomplish the high-low level control of a column operating at atmospheric pressure.



are covered in texts on instrumentation. In the application of such systems to distillation columns, however, the particular dynamic behavior of such columns can often cause problems.

Column temperatures respond in a relatively sluggish manner to operational disturbances and corrective control action. Improper selection and application of controls can produce sustained oscillation of operating variables. The result can easily be off-standard products. There is an ever-present danger of the controls failing to provide the required liquid-to-vapor ratios in the column, and then operation suffers. Indeed, it is relatively easy to lose separation entirely.

Experience in the application of automatic control theory to distillation columns is limited. One successful approach to the problem of designing satisfactory controls, is to design a reserve of performance ability into the distillation system and place all but one of the controllable variables on fixed-value control.

For example, make the column higher (more plates) and larger in diameter (higher allowable reflux and vapor rates), place the feed and boilup on fixed rate control, and control the reflux by temperature at a rate that guarantees satisfactory rectification. Thus the only disturbances to which the column is subjected are feed composition and feed enthalpy. With adequate reserve in reflux capacity, the feed disturbances would have negligible effect. It must be recognized, though, that there is a capital cost penalty in the over-designed column, and that the excess reflux rates and boilup increase heat and coolant consumption.

### Effect of External Disturbances

Within the material-handling capacity range of a given distillation column, i.e., between the excessive loadings at which flooding occurs and the very low loading at which draindown occurs, the quality of separation depends, to an important degree, upon column heat balance.

The point at which the heat is applied is also of importance. Heat introduced at the base of the column as boilup, for example, operates through a greater number of plates than does heat entering as feed enthalpy. Consequently, as we shall show, it is possible for separation to become poorer if boilup heat supply is decreased by controls, to compensate for an increase in feed enthalpy due to external conditions.

External disturbances, therefore, are quite significant to the extent that they upset column heat balance.

Composition controls are designed to mitigate the effects of such disturbances, but because of their customary location in the column—some number of plates removed from either the top or bottom of the column—they are deceived, to a minor extent, in assessment of the purity of product. In fact, they are deceived to a major extent in assessment of quantitative results of external disturbances.

A 15-plate toluene-benzene distillation has been analyzed to show the effects of several disturbances. Plate-by-plate calculations were made, using a digital

computer program. The analysis can be made, of course, using the McCabe-Thiele graphical solution. Indeed, the McCabe-Thiele diagrams of the disturbances analyzed are presented here because they convey a clearer picture of the effects of disturbances than does a tabulation of column operating data.

### McCabe-Thiele Diagram Analyzes Dynamics

We mentioned earlier locating of the composition-control temperature measurement in the column. Feedback regulation of the composition on the control plate has the effect of maintaining composition at the point in the column at a preselected value. Once chosen, this composition is constant. Also fixed are the number of plates above and below the control plate and, of course, above and below the feed plate.

On the McCabe-Thiele diagram, the product composition corresponds to intersection of operating lines with the 45° diagonal—the upper operating line for distillate composition, the lower for bottom composition. The effect of external column heat-balance disturbances is to shift the location of the operating lines on the diagram.

The McCabe-Thiele construction implicitly solves the column heat balance. But two other criteria must be met in the graphical solution of the effect of disturbances:

1. Composition on the control plate is held invariant by the composition controls.
2. Number of plates and locations of feed and control plates remain unchanged.

Any response of a distillation column to external disturbances must entail shifts in the locations of the column operating lines—in fact, the slopes will change. Moreover, it is clear that the slope changes of the upper and lower operating lines are opposite in sign.

The two criteria above require that construction of the perturbed operating line, by displacing it about the control plate, be done in such a way that the number of plates between it and the end of the column remain unchanged. This construction will be noted on Figs. 11 and 12.

The constraints fulfilled by construction of the upper operating line for Fig. 11, for example, are:

1. Slope of the operating line declined.
2. Graphical solution above the control plate corresponds to number of plates in upper column above the control plate.

Obviously, the decrease in slope of the upper column line can only cause a drop in distillate purity. A similar analysis holds for the effect of altering the slope of the lower operating line, where bottoms composition control is in operation.

To estimate the effect of external disturbances on separation, therefore, it remains only to determine the slope change on the operating lines and to construct the complete diagram in a way that accounts for the total number of plates and their deployment.

Figs. 11 and 12 represent the analysis of two typical external disturbances. Although these examples were precisely calculated by computer, a graphical analysis



by the McCabe-Thiele construction is just as informative and can be obtained in the absence of a digital computer or plate-by-plate calculation.

### Effect of Decreased Feed Enthalpy

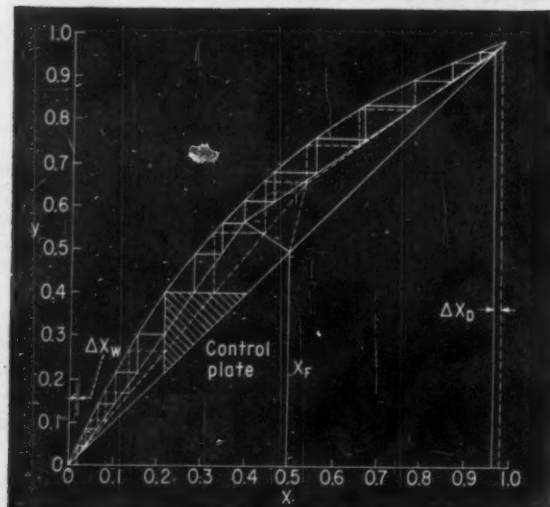
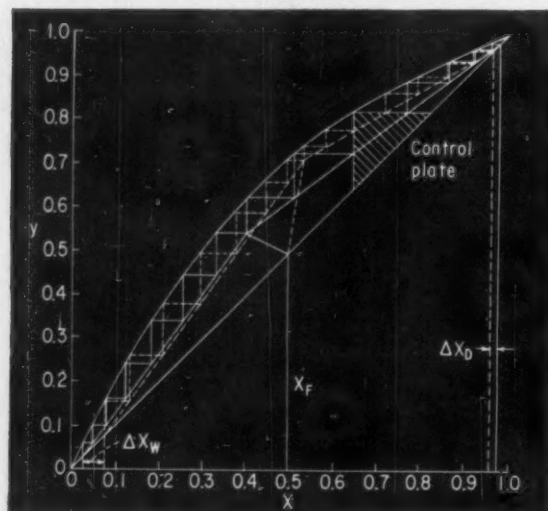
Fig. 11 shows the effects of decreasing the feed temperature on the toluene-benzene separation, operating with constant boilup and distillate composition control of reflux.

The effects are similar to those resulting from increased feed. The ratio of total heat to feed declines. The slope of the lower-column operating line increases, that of the upper-column operating line decreases, with a consequential degradation of separation.

The column temperature profile shifts downward below the feed plate, increases above it.

Fig. 12 shows the effect of lowered feed enthalpy on

### Diagrams show dynamics—Figs. 11, 12



the toluene-benzene separation, operating with constant reflux and composition control of boilup.

The decreased-enthalpy feed increases the liquid flow in the stripping section, and the boilup is increased by the control to make up for the loss in feed enthalpy. The total heat supplied is, therefore, held unchanged or, at worst, decreased only slightly. Before substantial fraction of the heat input is shifted from the feed plate to the bottom of the column, the separation actually improves slightly.

The temperature profile above the control plate, for this case, shifts downward, but below the control plate, it shifts to higher temperatures.

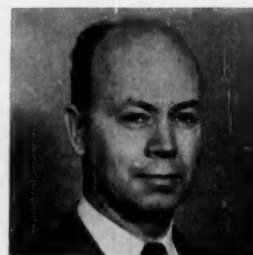
### Failure of Separation

Any disturbance that increases the demand for reflux or boilup can cause complete failure of separation if the limits of the column to handle the required liquid or vapor flow are exceeded, or if the capacity of the boilup or reflux facilities is exceeded.

Exceeding the liquid and vapor-handling capacity causes flooding. Virtually no separation occurs. A deficiency of boilup increases the slope of the lower operating line, and an unobtainable location of the lower operating line is called for. A deficiency of reflux decreases the slope of the upper-column operating line, with the similar result that an unobtainable location of the upper operating line is called for in the rectifying section.

With excessive feed rate and overtaxed reflux and boilup capabilities in a column, the control plate—whether in the top or bottom—would no longer be able to maintain its composition at the prescribed level.

### Meet the Authors



LOUIS BERTRAND has worked with process control and computer applications at Du Pont's engineering service division since 1952. He joined the company in '55, following graduation from the University of Cincinnati where he studied chemical engineering. He is a member of AIChE and ASME.

J. B. JONES is also a consultant in Du Pont's engineering service division. A graduate of the University of Oklahoma (B.S. Ch. E.) and the University of Michigan (M.S. Ch. E.), he worked for Standard Oil Co. (N. J.) in Baton Rouge before joining Du Pont. He is a member of AIChE.

## Analyze Material and Heat Balances for Continuous Distillation

Use these relations to calculate performance of existing equipment or to estimate the number of theoretical trays necessary to effect a given separation.

For large scale operations, continuous distillation is more economical than batch, especially where a steady supply of feed is available. One of the disadvantages of batch distillation is the multiplicity of distillations that are often necessary to effect complete separation of the components. Thus, it is often possible to produce a very pure overhead product by batch distillation but in order to obtain a high recovery, the residual liquid must be redistilled.

Use of, what is sometimes called, a compound distillation column affords a means of overcoming this disadvantage. A typical schematic setup for a column of this sort is shown in Fig. 1.

Referring to Fig. 1, at any point in the column, vapor passing upward through the trays contacts liquid flowing downward. In this contact, there is a transfer of the more volatile components from the liquid to the vapor while the less volatile components move from the vapor to the liquid.

Primary function of the section above the feed point is to remove the heavy components from the vapor. For this reason, this portion of the column is sometimes referred to as the absorption section, which properly describes its function. More commonly, however, the section above the feed point is denoted as the rectification section, in line with the idea that it serves to set-right the composition of the material moving up the column so that we can remove an almost pure product from the top.

Below the feed point, the primary function of the column is to remove the more volatile components from the liquid. This section is often called the stripping section. The two sections are shown in Fig. 1 and are typical of most continuous distillation columns. Thus, a column of this sort may be considered as a combination of absorption and stripping columns working together.

As in all chemical engineering processes, the overall material balance must first be made.

$$F = D + B \quad (1)$$

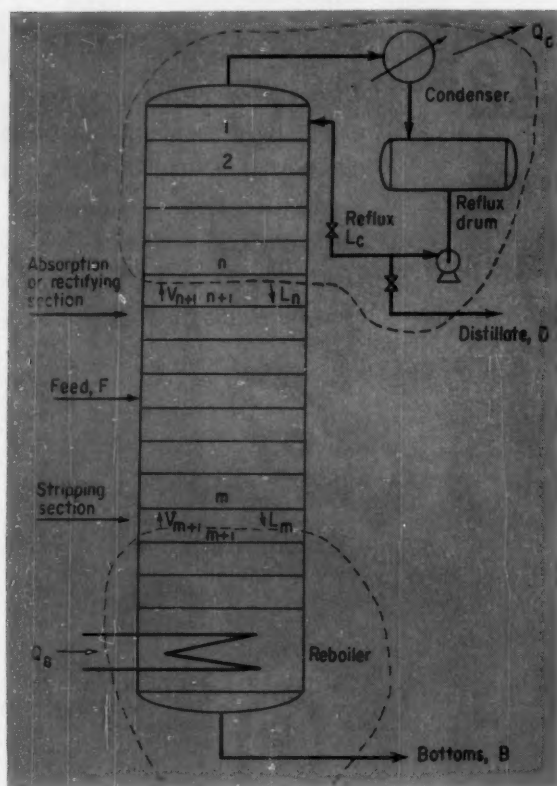
Individual component balance is given by:

$$FZ_F = Dx_D + Bx_B \quad (2)$$

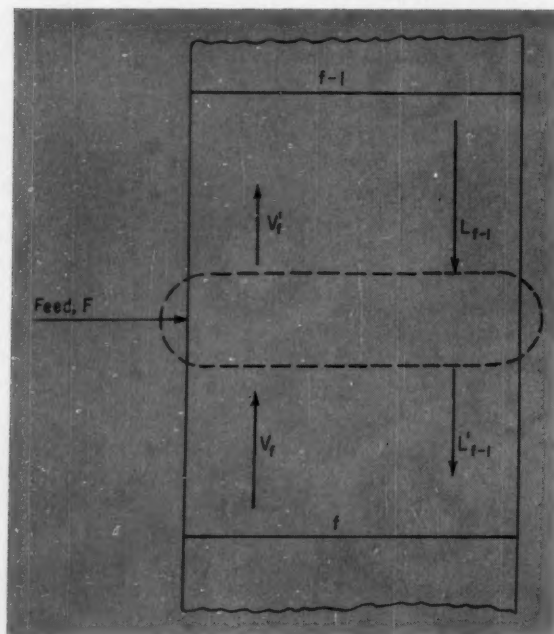
Eq. (2) must be satisfied for every component in

JESSE COATES and BERNARD S. PRESSBURG  
*Louisiana State University*

Flow patterns in distillation column—Fig. 1



Find stream flows at feed point—Fig. 2



the mixture. Combining Eqs. (1) and (2), we find:

$$\frac{D}{F} = \frac{Z_F - x_B}{x_D - x_B} \quad (3)$$

Hence, Eq. (3) gives the fraction of the feed that appears as distillate. The over-all heat balance for the entire unit must then be made. It is preferable to use the enthalpies of the various streams in making these balances.

$$FI_F + Q_B = DH_D + Bh_B + Q_C \quad (4)$$

It is often convenient to make use of the quantities:

$$q_B = Q_B/B \quad (5)$$

$$q_C = Q_C/D \quad (6)$$

$$h_B' = h_B - q_B \quad (7)$$

$$h_D' = H_D + q_C \quad (8)$$

Using these terms, Eq. (4) then becomes:

$$FI_F = Dh_D' + Bh_B' \quad (9)$$

Eq. (9) is of the same form as Eq. (2) and  $I_F$ ,  $h_D$  and  $h_B'$  are analogous to  $Z_F$ ,  $x_D$  and  $x_B$  respectively.

Combining Eqs. (9) and (1) and equating to Eq. (3) yields:

$$\frac{D}{F} = \frac{I_F - h_B'}{h_D' - h_B'} = \frac{Z_F - x_B}{x_D - x_B} \quad (10)$$

We will come back to the use of Eq. (10) shortly.

### Determine Column Operating Lines

Again referring to Fig. 1, a material balance around the section enclosed in the dashed line above the feed point gives:

$$V_{n+1} = L_n + D \quad (11)$$

and for the individual component balance gives:

$$V_{n+1}y_{n+1} = L_nx_n + Dx_D \quad (12)$$

This balance must be satisfied for every component. Rearranging Eq. (12) to solve for  $y_{n+1}$ , we get:

$$y_{n+1} = \frac{L_nx_n}{V_{n+1}} + \frac{Dx_D}{V_{n+1}} \quad (13)$$

This equation is often referred to as the equation for the upper operating line. Eq. (13) gives the relation between the composition of the vapor entering any tray and the composition of the liquid leaving any tray.

It is also necessary to satisfy the heat balance for the rectifying section. This relation is given by:

$$V_{n+1}H_{n+1} = L_nh_n + DH_D + Q_C = L_nh_n + Dh_D' \quad (14)$$

Using Eqs. (11), (12) and (14), we obtain the equality:

$$\frac{L_n}{V_{n+1}} = \frac{h_D' - H_{n+1}}{h_D' - h_n} = \frac{x_D - y_{n+1}}{x_D - x_n} \quad (15)$$

Eq. (15) is the slope of the upper operating line at any point in the rectifying section.

For the stripping section shown in Fig. 1, we make a material balance around the area enclosed in the dashed line below the feed point.

$$L_m = V_{m+1} + B \quad (16)$$

An individual component balance for the same boundary gives:

$$L_mx_m = V_{m+1}y_{m+1} + Bx_B \quad (17)$$

$$y_{m+1} = \frac{L_mx_m}{V_{m+1}} - \frac{Bx_B}{V_{m+1}} \quad (18)$$

Eq. (18) is referred to as the equation for the lower operating line. A heat balance on the stripping section yields:

$$L_m h_m + Q_B = V_{m+1} H_{m+1} + B h_B \quad (19)$$

$$L_m h_m = V_{m+1} H_{m+1} + B h_B' \quad (20)$$

Using Eqs. (16), (17) and (20), we obtain the equality:

$$\frac{V_{m+1}}{B} = \frac{h_m - h_B'}{H_{m+1} - h_m} = \frac{x_m - x_B}{y_{m+1} - x_m} \quad (21)$$

If we apply Eq. (21) with the boundaries around the reboiler, we get the boilup ratio and  $V_{m+1}$  becomes the vapor rate leaving the reboiler.

### Locate Column Feed Point

The stripping section and the rectifying section meet at the point at which the feed is introduced. The top tray of the stripping section is the feed tray, and the tray next above is the bottom tray in the rectifying section. In general, the feed tray is the first tray on which the feed has a chance to react with the liquid on the tray. Consequently, the above feed-tray designation is somewhat arbitrary.

Precisely what happens at the feed point depends on the type of physical action that occurs, whether an opportunity is afforded for good mixing of the feed and the streams of vapor and liquid flowing, to and from the feed point, from the rectifying and absorption sections. In the treatment that we give here, it is assumed that perfect mixing of the various streams occurs at the feed point.

In Fig. 2, the feed tray is designated as tray  $f$  and since we have adopted the system of numbering the trays from the top down, the tray above the feed tray is designated as tray  $(f-1)$ . The feed point is enclosed by the dashed line and the flow of the various streams into and away from this point are shown in the figure.

Vapor rate from the top tray in the stripping section is  $V_f$  and the liquid flow from the feed point to the top tray is  $L_{f-1}$ . Vapor rate entering the bottom tray of the rectifying section is  $V_f'$  and the rate of liquid flow leaving this tray is  $L_{f-1}'$ .

Material balance around the feed point is:

$$F + L_{f-1} + V_f = V_f' + L_{f-1}' \quad (22)$$

and the heat balance gives:

$$F I_F + L_{f-1} h_{f-1} + V_f H_f = V_f' H_f' + L_{f-1}' h_{f-1}' \quad (23)$$

Neglecting differences in sensible heat of the liquid and vapor streams entering the feed point, the assumption can be made that:  $h_{f-1} = h_{f-1}'$  and  $H_f = H_f'$ .

Using these assumptions, Eq. (23) becomes:

$$F I_F = h_{f-1}(L_{f-1}' - L_{f-1}) + H_f(V_f' - V_f) \quad (24)$$

It will be convenient to relate the two liquid streams  $L_{f-1}'$  and  $L_{f-1}$  by the equation:

$$\frac{L_{f-1}' - L_{f-1}}{F} = q \quad (25)$$

Using this definition and Eq. (22), we find:

$$V_f' - V_f = (1 - q) F \quad (26)$$

Substitution of Eqs. (25) and (26) into Eq. (24) and solving for  $q$  gives:

$$q = \frac{H_f - I_F}{H_f - h_{f-1}} \quad (27)$$

The denominator in Eq. (27) is approximately equal to the latent heat of the feed and the numerator is the quantity of heat required to convert the feed to saturated vapor. Using these approximations simplifies the numerical evaluation of  $q$ .

The two operating lines intersect at the feed point and have common coordinates designated by  $y_i$  and  $x_i$ . Writing the operating lines in terms of these coordinates:

$$V_f' y_i = L_{f-1}' x_i + D x_D \quad (28)$$

$$V_f y_i = L_{f-1} x_i - B x_B \quad (29)$$

Subtracting Eq. (29) from Eq. (28) and combining with Eq. (2) gives:

$$y_i(V_f' - V_f) = x_i(L_{f-1}' - L_{f-1}) + F Z_F \quad (30)$$

Substituting Eqs. (25) and (26) into Eq. (30) and solving for  $y_i$ , we obtain:

$$y_i = \left( \frac{q}{q-1} \right) x_i - \left( \frac{Z_F}{q-1} \right) \quad (31)$$

Eq. (31) is the locus of the point of intersection of the upper and lower operating lines.

### Evaluate Liquid-Vapor Ratio

As used here, the term reflux ratio designates the ratio of liquid downflow in the rectifying section to the distillate. If this ratio is evaluated for any tray, say tray  $n$ , it becomes  $L_n/D$  and is referred to as the internal reflux ratio. If it is evaluated at the condenser, it becomes  $L_c/D$  and is referred to as the pumpback reflux ratio. Slope of the upper operating line at any point is related to the internal reflux ratio by:

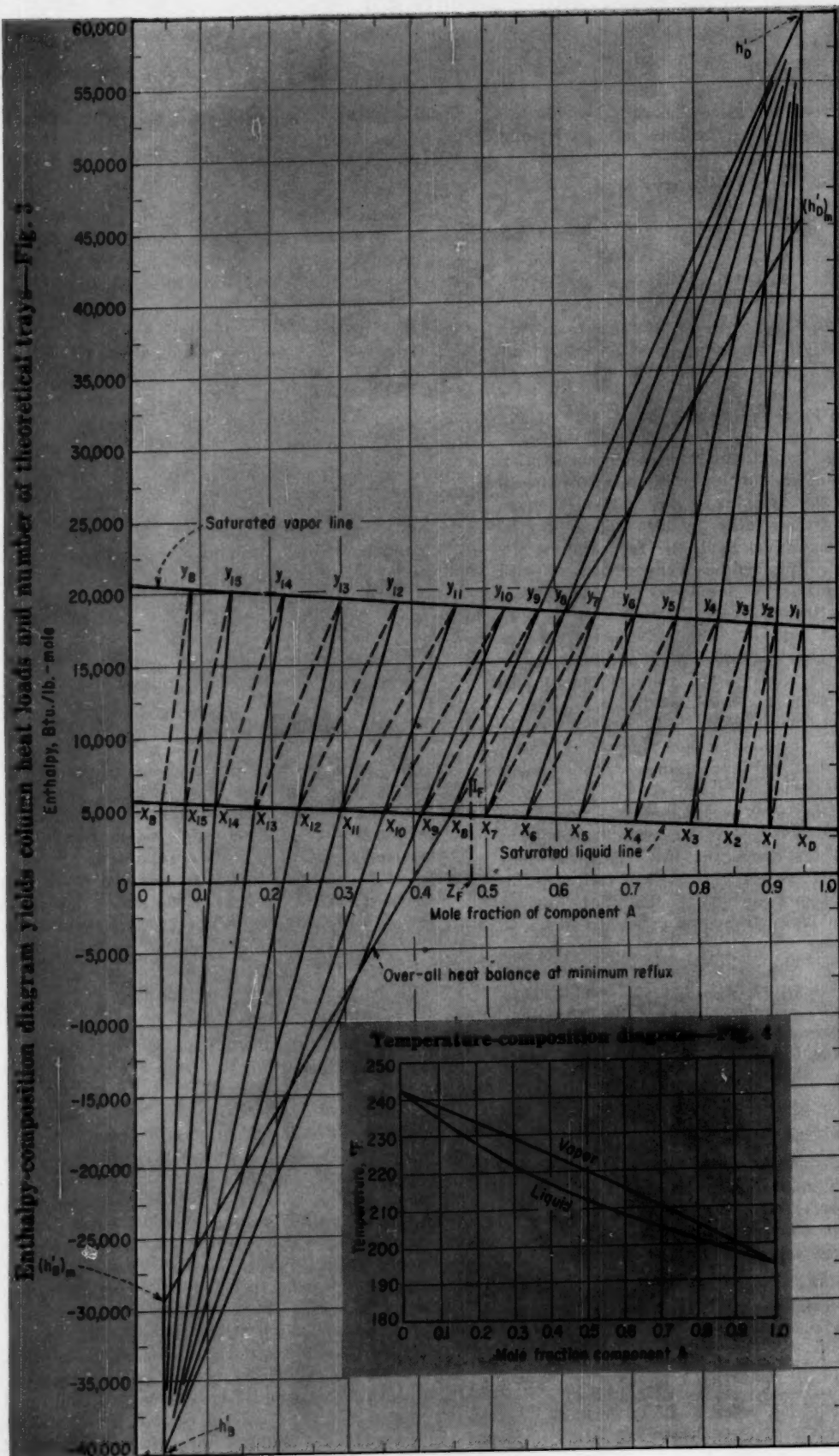
$$\frac{L_n}{V_{n+1}} = \frac{L_n/D}{1 + (L_n/D)} \quad (32)$$

Eq. (15) along with Eq. (32) relate the internal reflux ratio to the enthalpy of the vapor entering any tray and the enthalpy of the liquid leaving the same tray.

In going up the column from the feed point, both  $H_{n+1}$  and  $h_n$  decrease. For some systems, however, the decrease in these quantities is such that the ratio of liquid to vapor remains constant in moving from tray to tray. Referring to Eq. (32), this results in  $L_n$  remaining constant as the liquid flows from tray to tray. Consequently,  $V_{n+1}$  also remains constant in the rectifying section. This results in what is commonly called constant molal overflow and vapor upflow.

Systems in which this condition can be realized are usually those in which the molal latent heat of vaporization of the components are nearly the same, and in which the loss in the sensible heat of the vapor is balanced by the gain in sensible heat of the liquid as it passes across the tray. A similar treatment for Eq. (21) will show that constant molal overflow and





vapor upflow can be attained in the stripping section. For this special case, both of the operating line equations become those of straight lines. We often find it convenient to make the assumption of constant molal overflow and vapor upflow in distillation calculations.

Up to this point, we have developed a set of working equations that may be used to estimate the number of theoretical trays required for a given separation or that may be used in calculations concerning the performance of existing equipment.

As these equations stand, they are correct for either binary-distillation or multicomponent-distillation calculations. However, the direct application of these relations to multicomponent distillation is much more difficult than for binary systems. In this article, we will limit their direct application to binary distillation calculations. In doing this, we will show certain analogous applications to multicomponent distillation and point out some of the pitfalls for this usage.

### Calculate Number of Theoretical Trays

The number of theoretical trays may be calculated from either the heat and material balance equations or from the material balance equations alone. The best procedure is to use both the heat and material balances. In many cases, however, satisfactory results can be obtained in much less time by use of the material balance relations alone. We will discuss both situations. In either case, the over-all material balances Eqs. (1) and (2) must be satisfied.

For the moment, we will confine our attention to the combined heat and material balance equations. Eq. (10), referred to as the over-all heat-balance operating line, is a straight line on a plot of enthalpy versus composition such as Fig. 3. The line passes through points  $(h_D', x_D)$ ,  $(I_F, Z_F)$  and  $(h_B', x_B)$ . Since the line is straight, it can be drawn from any two of the three points.

Eq. (15) is called the upper heat-balance operating line and is also a straight line on the enthalpy-composition diagram. Three points are defined by this equation  $(h_D', x_D)$ ,  $(h_m, x_m)$  and  $(H_{n+1}, y_{n+1})$ . All operating lines above the feed point pivot around point  $(h_D', x_D)$ . The other two points relate the enthalpy and composition of the vapor entering any tray in the rectifying section to the enthalpy and composition of the liquid leaving the tray.

The lower heat-balance operating line Eq. (21) passes through points  $(h_B', x_B)$ ,  $(h_m, x_m)$  and  $(H_{n+1}, y_{n+1})$ . All operating lines below the feed point pivot around point  $(h_B', x_B)$ . Points  $(H_{n+1}, y_{n+1})$ ,  $(h_m, x_m)$  relate enthalpy and composition of the vapor entering any tray in the stripping section to enthalpy and composition of the liquid leaving the tray.

To use these relations, an enthalpy-composition diagram must be available or must be constructed. The procedure for constructing such a diagram is described adequately in standard textbooks and will not be discussed here.

We have prepared an enthalpy-composition diagram as shown in Fig. 3 for hypothetical components A and

B that have boiling points of 195 F. and 242 F., respectively. The composition coordinates of tie lines or isotherms, connecting the equilibrium composition of the liquid with that of the vapor, can be read from either a temperature-composition diagram as in Fig. 4 or an equilibrium diagram. These tie lines can be plotted as needed.

### How to Calculate Number of Trays

The procedure to be followed for a given pumpback reflux ratio  $L_c/D$  is summarized here:

1. Apply Eqs. (11) and (14) at the condenser. Using  $V_{n+1} = V_1$ ,  $L_n = L_c$ ,  $H_{n+1} = H_1$  and  $h_n = h_c$ , we calculate  $h_D'$ . From this and  $H_D$ , we can calculate  $Q_c$  if desired. Plot the point  $(h_D', x_D)$  on Fig. 3.

2. Determine the enthalpy of the feed  $I_F$  from the thermal condition of the feed. With this value and Eq. (9),  $h_B'$  can be calculated. Points  $(h_B', x_B)$  and  $(I_F, Z_F)$  are now known and either of these along with  $(h_D', x_D)$  can be used to plot the over-all heat balance operating line.

3. Next, use the upper heat-balance operating line Eq. (15) in a stepwise fashion. For example, if a total condenser is used,  $y_1 = x_D$  and  $x_1$  lies on the liquid line at the other end of a tie line connecting the equilibrium vapor with the equilibrium liquid. A line drawn through  $x_1$  to  $(h_D', x_D)$  intersects the vapor line at  $y_2$ . A tie line connects  $y_2$  with  $x_2$  on the liquid line. A line connecting  $x_2$  and  $(h_D', x_D)$  intersects the vapor line at  $y_3$ . This procedure is continued until the feed point is reached.

4. Calculate the composition of the liquid and vapor for the feed tie line from the thermal condition of the feed. Equate the  $q$ -line Eq. (31) to the equilibrium relation at this point as follows:

$$y_i = \left( \frac{q}{q-1} \right) x_i - \frac{Z_F}{q-1} = \frac{\alpha_i x_i}{1 + (\alpha_i - 1)x_i}$$

When the value of  $x$  from the upper operating line falls below the value of  $x$  on the feed point tie line, we shift to the lower heat-balance operating line Eq. (21).

5. A line passing through the last value of  $x$  obtained from the upper operating line and point  $(h_B', x_B)$  intersects the vapor line at the composition of the vapor entering the feed tray.

6. As before, tie lines connect the equilibrium vapor and liquid compositions, and operating lines give the composition of the vapor entering relative to that of the liquid leaving the tray.

7. Use the lower operating line equations until the composition of the liquid becomes equal to  $x_B$ .

### Example Illustrates Method

Feed to a distillation column consists of 48 mole % component A and 52 mole % component B. This mixture is to be separated into a distillate containing 95 mole % A and a bottoms product containing 4 mole % A. The feed is 20 mole % vapor. A total condenser will be used and column will operate at a total pres-

sure of one atm. At this pressure, the boiling point of pure A is 195 F. and that of pure B is 242 F. An enthalpy-concentration diagram as shown in Fig. 3 has been prepared for this system.

Using this diagram, calculate the number of theoretical plates for a pumpback reflux ratio  $L_c/D$  of 2.922. What are the condenser and reboiler heat loads per 100 moles of feed? What are the minimum number of plates and the minimum reflux ratio that can be used?

On the basis of 100 lb.-moles of feed,  $Z_F = 0.48$ ,  $x_D = 0.95$ ,  $x_B = 0.04$  mole fraction A. From Eq. (3):

$$\frac{D}{F} = \frac{0.48 - 0.04}{0.95 - 0.04} = 0.483$$

Hence,  $D = 48.3$  lb.-moles and  $B = 51.7$  lb.-moles. Since pumpback reflux ratio is 2.922, we find  $L_c$  is  $2.922 \times 48.3$  or 141 lb.-moles. Also, top tray vapor  $V_1$  equals 141 plus 48.3 or 189.3 lb.-moles.

For a total condenser,  $x_D = y_1 = 0.95$ . From Fig. 3,  $H_1 = 17,300$  Btu./lb.-mole. Since  $x_D = x_C = 0.95$ , we find that  $H_D = h_C = 3,400$  Btu./lb.-mole.

From Eq. (14), we calculate heat balance for rectifying section as:

$$189.3 \times 17,300 = 141 \times 3,400 + 48.3 h_{D'}$$

$$h_{D'} = 57,900 = H_D + q_C$$

$$q_C = 57,900 - 3,400 = 54,500 \text{ Btu./lb.-mole of distillate.}$$

$$Q_C = 54,500 \times 48.3 = 2.63 \times 10^6 \text{ Btu./100 moles of feed.}$$

An equilibrium flash calculation on the feed gives its temperature at 215 F. with the ends of the feed tie line defined by  $y = 0.617$  and  $x = 0.4463$ . Since the feed is part vapor,  $I_F$  lies on this tie line. From Fig. 3,  $I_F = 7,250$  Btu./lb.-mole. Using Eq. (9), we get  $h_B' = -40,000$  Btu. At  $x_B = 0.04$ , we read  $h_B$  as 5,800 Btu./lb.-mole on the liquid line of Fig. 3. Therefore:

$$q_B = 5,800 - (-40,000) = 45,800$$

$$Q_B = 45,800 \times 51.7 = 2.372 \times 10^6 \text{ Btu./100 lb.-moles of feed}$$

Points  $(h_{D'}, x_D)$ ,  $(I_F, Z_F)$  and  $(h_B', x_B)$  are now plotted\* on Fig. 3. These points are designated as  $h_{D'}$ ,  $I_F$  and  $h_B'$ . The over-all heat balance line can be drawn but this is not necessary.

From  $y_1 = 0.95$  and the equilibrium tie line, shown as a dotted line in Fig. 3,  $x_1$  is read as 0.905. A line connecting  $x_1$  to point  $h_{D'}$  intersects the vapor line at  $y_2$ . The tie line from this point to the liquid line gives  $x_2$ . An operating line connecting  $x_2$  to  $h_{D'}$  intersects the vapor line at  $y_3$ . This procedure is continued until  $x$  becomes equal to or less than the  $x$  for the feed tie line. This occurs at tray number 9, which is below the condenser. This is the feed tray, for which  $x = 0.41$ .

We now shift to the lower heat-balance operating line. A straight line drawn through  $x_B$  and point  $h_B'$  intersects the vapor line at  $y_{10}$  where  $y = 0.525$ . This is the composition of the vapor entering the feed tray. A tie line from  $y_{10}$  to the liquid line gives the value of  $x_{10}$ . The stepwise construction of these oper-

ating lines with the assistance of the tie line is continued downward toward the reboiler until a tie line connects the reboiler vapor to the reboiler liquid.

Fig. 3 shows the operating and tie line for this separation. From this figure, a total of 15 plates plus the reboiler and condenser are required. The feed plate is number 9 below the condenser.

If desired the flow of liquid and vapor to or from each tray can be calculated by using Eqs. (11) and (15) for the rectifying section and Eqs. (16) and (21) for the stripping section.

To obtain minimum reflux ratio, for this case, the feed tie line is extended to intersect abscissa  $x_D = 0.95$  at  $(h_{D'})_m = 45,500$  Btu. Extension of the feed tie line to abscissa where  $x_B = 0.04$  gives  $(h_B')_m$  of -28,400 Btu. These points are shown in Fig. 3. Using these values,  $(Q_C)_{min}$  is  $2.033 \times 10^6$  and  $(Q_B)_{min}$  is  $1.769 \times 10^6$  Btu. per 100 lb.-moles of feed.

Applying Eq. (14) around the condenser along with Eq. (11) gives an  $(L_c)_{min}$  of 98 lb.-moles and a minimum pumpback reflux ratio  $(L_c/D)_{min}$  of 98/48.3 or 2.03 moles reflux per mole distillate.

#### Nomenclature

$B$	Bottoms rate, moles/unit time.
$D$	Distillate rate, moles/unit time.
$F$	Feed rate, moles/unit time.
$H$	Enthalpy of vapor, Btu./lb.-mole.
$H_D$	Enthalpy of distillate, Btu./lb.-mole.
$h$	Enthalpy of liquid, Btu./lb.-mole.
$h_B$	Enthalpy of bottoms, Btu./lb.-mole.
$h_{D'}$	Defined by Eq. (7).
$h_C$	Enthalpy of pumpback reflux, Btu./lb.-mole.
$h_{D''}$	Defined by Eq. (8).
$I_F$	Enthalpy of feed, Btu./lb.-mole.
$L$	Liquid rate, moles/unit time.
$L_c$	Pumpback reflux rate, moles/unit time.
$Q_B$	Reboiler heat load, Btu./unit time.
$Q_C$	Condenser heat load, Btu./unit time.
$q$	Defined by Eq. (25).
$q_B$	Defined by Eq. (5).
$q_C$	Defined by Eq. (6).
$V$	Vapor rate, moles/unit time.
$x$	Mole fraction of component in liquid.
$x_B$	Mole fraction of component in bottoms.
$x_D$	Mole fraction of component in distillate.
$y$	Mole fraction of component in vapor.
$Z_F$	Mole fraction of component in feed.

#### Subscripts

$m, m+1$ , etc. Designate plates in stripping section.  
 $n, n+1$ , etc. Designate plates in rectifying section.

#### Still to Come on Distillation . . .

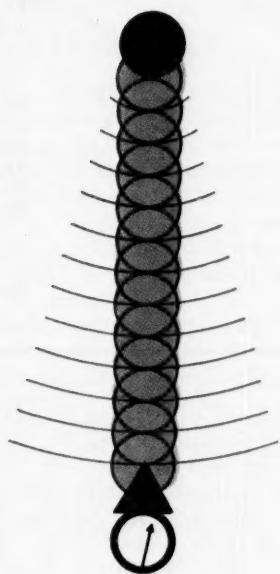
Two remaining Refresher sections on distillation will include:

- Determining minimum reflux.
- How to develop and use the McCabe-Thiele diagram.
- The analytical method for finding theoretical plates.
- Determining total reflux.
- How to calculate tray efficiency.

\* Values obtained from Fig. 3 were originally determined from a chart having an ordinate about three times as large. The ordinate has been compressed to accommodate Fig. 3 to magazine page size.



# Radioisotopes Help Solve CPI Engineering Problems



RALPH T. OVERMAN AND F. A. ROHRMAN  
*Oak Ridge Institute of Nuclear Studies*

Chemical engineers have shown great interest in nuclear power research, development and engineering. On the other hand, they have paid little attention to the many industrial possibilities of radioisotopes. No part of the chemical, metallurgical or petroleum industry can afford to ignore progress, if not potentials, in use of radiation and radioisotopes in research, control and production.

Probably the first reference to the use of radioactivity in fluid flow and process instrumentation was made in 1913, as reported by Hevesy and Paneth.<sup>10</sup> Here, stream flow was traced by addition of radioactive ma-

terials to the water. It is well known that the petroleum industry has led all others in the use of radioisotope techniques.

## Why Radioisotopes

Radioisotopes or radiochemicals are useful because of the inherent property of a radioactive element to emit penetrating radiation that can be readily detected and evaluated by special instrumentation. The great advantage is that an extremely small amount of radioactive material can be traced through a complicated process without visible disturbance to the processed material.

For example, radioactive sodium, Na-24, can be detected when as little as  $4 \times 10^{-10}$  grams/liter is present in solution. This detection sensitivity is many million times greater than can be expected from any conventional means. As radioactivity detecting equipment and techniques are improved, there is no reason to doubt that even greater sensitivities can be attained.

Other than great detection sensitivity, one can also cite the following advantages of radioisotope utilization in chemical engineering:

- The ability to measure densities of flowing materials without actually seeing, touching, or physically disturbing the materials.
- The compatibility of specific radiochemicals with specific processed materials.
- The ability to select radioisotopes having a long or short life and those having low or high penetrating power.
- The continuity of radioactivity and the absence of any variables other than those derived from nuclear properties.

The chief drawback in the use of radiochemicals and radioisotopes is lack of information and training. Ignorance breeds fear and fear breeds distrust and dislike. For this reason, the workman, technician, engineer and scientist must be informed about the nature, handling and use of radioisotopes and radiochemicals.

There are over 5,000 licensed users of radioisotopes in over 1,500 cities and towns in the U.S., yet this is a small number when one considers the size of the entire country and its industrial capacity. The demand for training in the use of radioisotopes is increasing every day. There are several centers, such as the Oak Ridge Institute of Nuclear Studies, where short courses on this subject are given repetitively to accommodate industry, education and the professions.

## Radiation Hazards

Because of the potential radiation hazards that can be created by careless or ignorant handling of these agents, strict safety precautions must be established in their distribution and use. This has called for education, training and some government regulations. The possibility of public liability has also been a problem. However, it is reasonable to say that most radioisotopes can be employed in chemical engineering operations with no more danger than would be incurred by



Isotopes recommended for various operations—Table I

Operation	Recommended Isotope	Reference
Steam quality (density)	Thulium-170	6
Liquid density	Cobalt-60, cesium-137	5
Density measurements	Cobalt-60, cesium-137	36
Air flow	Bromine-82, radon	11, 21
Aqueous flow	Cesium-134	3, 12, 13, 22
Aqueous flow in large pipes	Sodium-24	9, 23
Aqueous flow through porous media	Phosphorus-32	25
Liquid flow	Iodine-131, antimony-124, rubidium-86, cobalt-60, cesium-137, sodium-24	35, 36
Gas and liquid flow	Sodium-24	34
Petroleum and oil flow	Barium-140	15
Petroleum and oil flow	Sulfur-35	22
General flow studies	Hydrogen-3, krypton-85, bromine-82, iodine-131, iodine-132, rubidium-86	16
Fluidized systems	Cobalt-60, cesium-137	2
Catalyst stack losses	Scandium-46, cobalt-60, iridium-192	4, 17, 31
Distillation	Antimony-127	7, 19
Mixing	Manganese-56	33
Mixing of solids	Sodium-24	4
Mixing of solids	Colloidal gold-194	See text
Mixing of greases	Iodine-132	14
Mixing of carbon pastes	Sodium-24	4
Catalytic mixing patterns	Scandium-46, cerium-144	28, 29
Filtration	Phosphorus-32	1, 27
Extraction	Carbon-14, cesium-137	24, 26

using many acids and bases, high-pressure steam or high-temperature materials. The health and safety records of concerns employing radioactive materials are excellent and attest to this statement.

Many radiochemicals are available to anyone today because of their low radiation intensity and relative freedom from hazard; small quantities of them are "generally licensed" and can be purchased and used without AEC authorization. Over 100 firms in this country are in the business of processing, packaging and distributing radioactive materials. One has his choice of almost any kind of radioactive isotope or chemical today: organic or inorganic, gaseous, liquid or solid, concentrated or dilute. For obvious reasons, the use of large quantities of the more hazardous ones are under strict government regulation as to purchase, shipment, use and inventory. Only licensed individuals are legally authorized to obtain and handle large quantities of such isotopes and chemicals.

### Radioisotope Selection

A number of chemical engineers have reported on suitability and adaptability of various radioisotopes and radiochemicals in engineering operations. In general, one can say that a penetrating, long-lived gamma emitter is often applied in measurements using sealed

sources, while a less penetrating gamma or beta emitter, of shorter half-life, is used for tracer work. Although the very weak beta emitters, like hydrogen-3 (tritium) and carbon-14, require special detection instruments and techniques for their use, they have certain highly desirable properties for tracer work.

Hydrogen-3 and carbon-14 can be obtained from a number of organizations, and in many different gaseous, liquid and solid, organic and inorganic compounds. Generally, licensed quantities of these "tagged" agents are safe to use.

Radioisotopes of 7 to 30 days half-life have the optimum properties for most tracer work.<sup>30</sup> A half-life shorter than 7 days involves problems of time schedules, and a longer half-life than 30 days introduces the problems of lingering radiation and waste disposal. For entrainment studies, gamma emitters have been recommended over beta emitters; the energy of the emitter should be over 0.2 Mev. Barium-140 emits betas of 1.022 and 0.480 Mev. and has a half-life of 12.8 days. Lanthanum-140 emits betas of 1.34 to 2.15 Mev. and gammas of 0.09 to 1.60 Mev. It has a fairly short half-life of 40.2 hr.

For water stream studies, using the total count method, the use of cesium-134 (in the form of cesium chloride, diluted in a 1% sodium chloride solution) has been recommended. In petroleum flow studies, oil

soluble compounds of barium-140 have been recommended. Barium-140 disintegrates to lanthanum-140, which has a shorter half-life. The use of sulfur-35 has also been proposed because of its adequate beta emission and a half-life of 87 days.

## Applications

In a general review, Koch<sup>18</sup> has pointed out that radioisotopes can be used for studying:

- Equilibria in chemical and physical systems.
- Chemical reaction mechanisms and kinetics.
- Surface properties and reactions.
- Detergent or other cleaning actions.
- Chemical process development.
- Mixing and blending operations.
- Transport phenomena.
- Filter efficiency.

## Gas, Vapor and Liquid Flow

Probably the most universally important problem in fluid dynamics is the general study of turbulence in fluids. Specifically, this includes the study of homogeneous turbulence, turbulent shear flow, boundary layer study and turbulent pipe flow. The use of radioisotopes may lead to great progress in these areas, especially in fundamental studies. The ease with which such studies can be made should be an inducement for some excellent research problems.

In these operations, one may either introduce a radiochemical that is compatible with the flow material, or make density measurements by measuring radiation attenuation through the pipe walls from external radiation sources. The selection of the radiochemical within the limits previously described is not difficult, nor is its introduction to the flow material. The quantities employed are, at most, insignificant compared with the mass of flow material. By introducing sodium-24 and using special radiometric techniques, it has been possible to study water flow in large (50-in.) diameter pipes and to determine fluid profiles within 0.002 in. of the inside surface of the pipe walls. One need not be reminded that such measurements offer possible breakthroughs in studies dependent upon boundary layers.

Bromine-82, in the form of methyl bromide ( $\text{CH}_3\text{Br}$ ), has been used to study turbulent diffusion and the mixing of air and gas. Radon (a mixture of radon isotopes) has been introduced in air mixtures to trace air in aerodynamic studies in wind tunnels.

Steam quality has been evaluated directly by the use of thulium-170 as a source of radioactivity on one side of a  $\frac{3}{4}$ -in. pipe, with an ion detection chamber on the other side. As the moisture content of the steam increases, the density increases; this attenuates the radioactive beam so that a difference in reading can be recorded. By the use of a calibrated chart, steam quality can be established with good accuracy. Anyone familiar with the determination of steam quality by conventional methods will recognize the saving in

time and equipment that is offered by this method.

Continuous density recordings on petroleum products flowing in pipes have been made by using cobalt-60 and cesium-137. The accuracy of such measurements increases with the increase in pipe diameter. In a 24-in. pipe, it was possible to detect differences of  $\frac{1}{4}^\circ$  API or 0.001 gm./cc. Convective flow through porous media has been studied by injecting phosphorus-32 and detecting the counting-rate changes in water dispersed through the granular solids. The radioisotopes of iodine, iodine-131 and iodine-132, as well as hydrogen-3, krypton-85, bromine-82 and rubidium-86 have also been used in fluid flow studies. These examples show how the use of radioactivity, either as an additive to a flowing system or as an outside gamma source, may be used for liquid and gas flow studies.

Studies in fluidized systems involving density and solids concentration measurements have been made employing cobalt-60 and cesium-137 as exterior radioactive sources. Sodium-24 has been reported as a satisfactory tracer in control studies on the flow of solid materials in cement kilns.

In our applications laboratory at Oak Ridge, we employ 396 ft. of 2 $\frac{1}{2}$ -in. I.D. steel pipe, with three returns, to make flow studies. A small centrifugal pump, capable of moving up to 30 gpm., is contained in the system. Two Geiger-Mueller exterior detectors are positioned at two points in this flow system. Colloidal, radioactive gold-198 is used as the tracer material. After injecting a little of the radioactive material into the system, we make many studies of interface continuity, mixing by turbulent flow, time of movement, and the like.

It would appear that there is considerable room for research in the area of fluid flow, friction studies and boundary layer problems by the use of radioisotope techniques. With a little more familiarity and train-

Half-lives of typical isotopes—Table II

Antimony-124	60 days
Antimony-127	93 hr.
Barium-140	12.8 days
Bromine-82	35.7 hr.
Carbon-14	5,700 yr.
Cerium-144	290 days
Cesium-134	2.3 yr.
Cesium-137	33 yr.
Cobalt-60	5.25 yr.
Gold-194	39.5 hr.
Gold-198	2.7 days
Hydrogen-3 (Tritium)	12.5 yr.
Iodine-131	8.04 days
Iodine-132	2.4 hr.
Iridium-192	74.7 days
Krypton-85	9.4 yr.
Lanthanum-140	40.0 hr.
Manganese-56	2.59 hr.
Phosphorus-32	14.3 days
Rubidium-86	19.5 days
Scandium-46	85 days
Sodium-24	14.9 hr.
Sulfur-35	87.1 days
Thulium-170	127 days



Unique mobile nuclear lab, used for training industrial groups, has positions for six students working at once.

ing in these techniques, many of the vexing problems of fluid flow can probably be solved.

### Distillation

The petroleum industry has pioneered some of the original work in the use of radioisotopes in distillation phenomena. Oil-soluble antimony-127 compounds have been used to study fractionation-tower flow patterns. In these tests, Geiger counters were used outside the 12 to 27-ft.-dia. towers, with a radioactive source on the inside. Antimony-124, in the form of triphenylstibine, has been used to study the flow distribution in a large vacuum distilling column and the efficiency of vapor scrubbing around the bubble caps.

Should one desire to make studies on column or tray efficiencies, packing efficiencies, diameter versus height, rate of throughput, etc., the use of a radioisotope tagged to either of the components, or the use of an outside radioactive source, should give speedy and profitable results. If the tagging is done with carbon-14 or hydrogen-3, special instrumentation techniques should be employed. If the outside source is an energetic gamma, a Geiger counter can be used for density attenuation measurements on the components in the column.

### Mixing, Extraction and Filtration

In all work involving mixing and blending, it is recognized that an insufficient amount results in unsatisfactory heterogeneity, whereas an excessive amount is uneconomical of power and time. Iodine-132 has been employed in studying grease mixing, cobalt-60 with catalysts, and barium-140 at material interfaces. Sodium-24 has been added to carbon paste to observe mixing efficiencies in electrode manufacture. Iridium-192 has been introduced to study loss of plati-

num-iridium catalyst material in nitric acid manufacture.

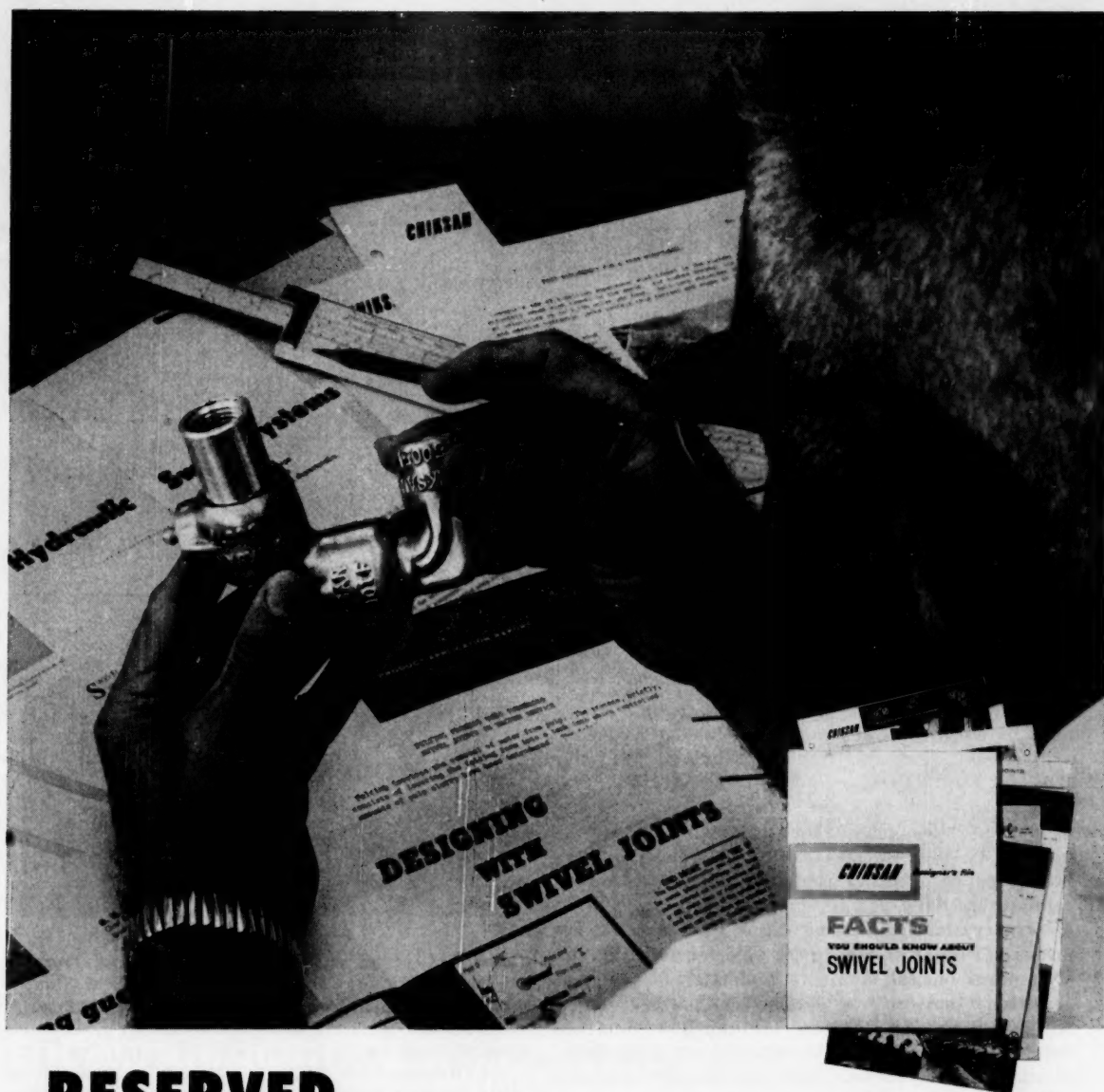
In our laboratories at Oak Ridge, we employ two 4-ft. × 6-ft., 550-gal. steel tanks for making one set of mixing studies. Each tank has 12 exterior points for the application of a Geiger-Mueller detector. The isotope used in these studies is colloidal gold-198, which serves excellently.

One should be careful in his choice of radioactive materials and not employ solutions of radioactive noble metals in equipment of less-noble metals. The use of colloidal gold, rather than a solution of gold, eliminates any possibility of the more-noble isotope plating out on the less-noble equipment.

Some of our studies have involved rate of mixing, position of stirrer, residence time of one component as it is drained while another component is added, influence of point of isotope injection, and the like. It is easy to demonstrate how certain portions of the liquid resist mixing, depending on the positioning of the stirrer. In another set of studies, we have employed a small cement mixer to study the efficiency of mixing, with relation to time, on heavier and less homogeneous material; gold-198 is again used as the tracer in this work.

Radioisotopes offer considerable assistance in extraction and filtration studies. There is always the problem of optimum extraction, which in some instances is of extreme importance when purity is to be considered. The inefficient extraction of an undesired component from another, such as material adhering to a precipitate, can be costly. The addition of traces of the radiochemical to its nonradioactive counterpart makes it simple to detect efficient or inefficient removal. An example might be the washing and removal of iron from titanium oxide precipitates. A trace of iron remaining in the titanium oxide reduces its whiteness considerably. By using an iron tracer, we can readily





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trace and find it if it is present, which would be difficult by conventional analytical means.

The filtration of certain bacteria from biochemical solutions has presented difficulty because of the tendency for holes to form on the cake, thus introducing inefficient filtration. Phosphorus-32 was employed to locate holes in such bacterial filters. The phosphorus chemical was fed to bacteria and carried by them, so they could be detected if they passed through the filter. It was later found to be more practicable to use radioactive-gold-covered particles to detect such filter holes. Scintillation-counter methods were shown to be most satisfactory in these studies. The same techniques were applied to dyes in order to trace carryover after washing.

In monitoring multicomponent, two-phase, liquid-liquid extraction systems, cesium-137 was employed. In this case, the radioactive component was soluble in one of the systems and not in the other. In the study of certain organic, liquid-liquid phase extractions, carbon-14 proved satisfactory.

## Other Applications

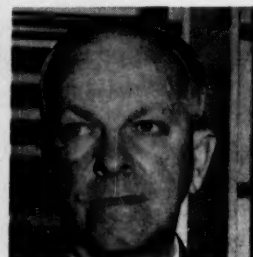
It has been pointed out that a major cost in the fluid catalytic cracking process is the daily requirement of fresh catalyst. It was possible to follow the daily catalyst feed and catalyst loss by using a highly sensitive scintillation counter, and scandium-46 as a chloride dissolved in water, which was added to the catalyst to the extent of about 0.27 ppm. of scandium.

Scandium-46 and cerium-144 as chlorides have been used in studying catalyst mixing patterns in catalytic cracking units. When using these isotopes, a large crystal scintillating dip counter and a large amount (1 liter) of sample are used for counting. By such means, one can obtain approximately 50 times the sensitivity that could be obtained with Geiger counters.\* With the same tracers, one can determine loss rates of fresh catalysts in catalytic cracking units. Mixing of catalysts and stack loss studies have also relied upon cobalt-60.

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## Meet the Authors



Ralph T. Overman is Chairman of the Special Training Division, Oak Ridge (Tenn.) Institute of Nuclear Studies. The Institute offers training in the use of radioisotopes to scientists and engineers, and has trained over 4,000 people from 57 countries.

Dr. Overman holds the AB and MS degrees from Kansas State Teachers College, and a PhD from Louisiana State University.

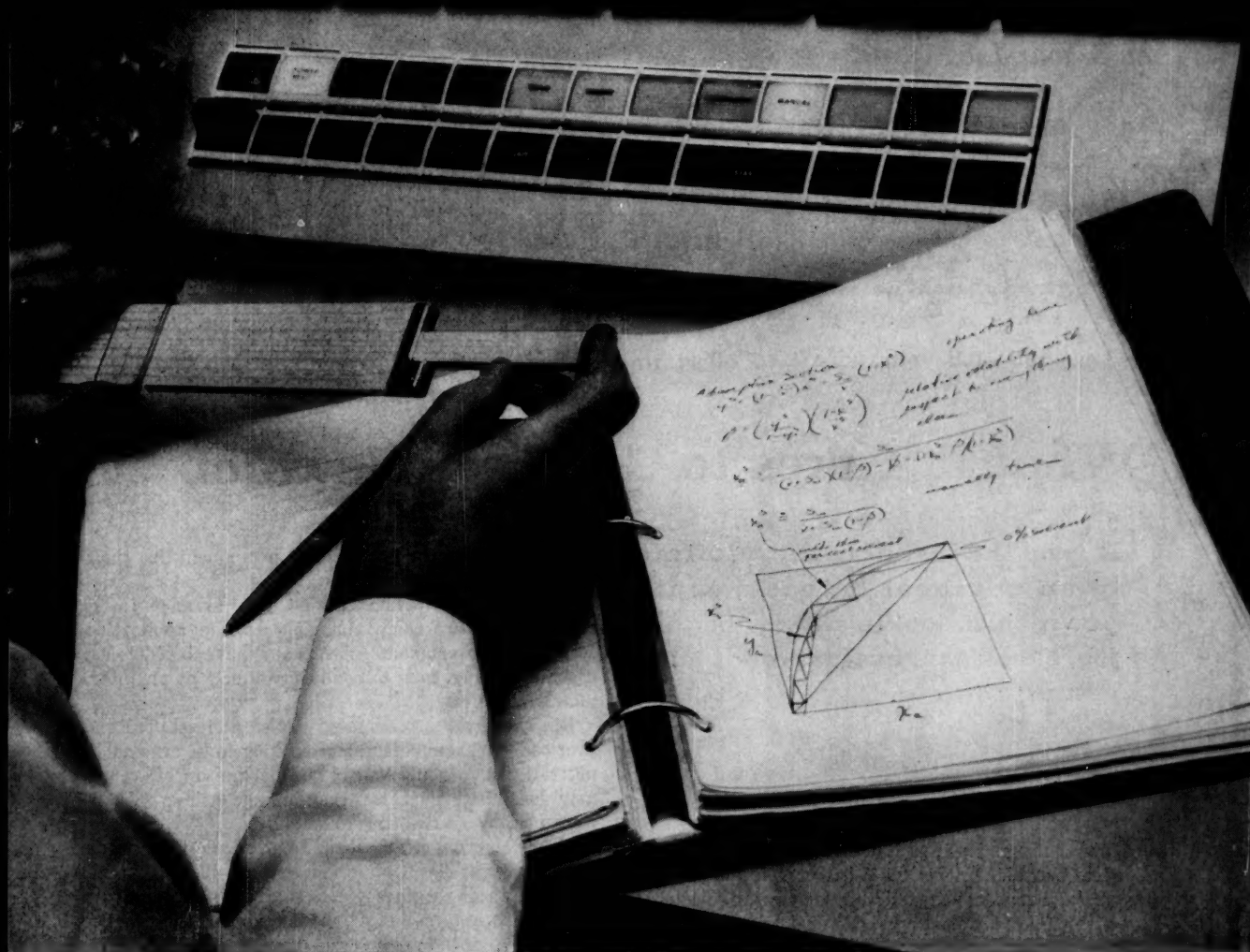
Previously, he was Senior Research Chemist at the Oak Ridge National Laboratory, and Technical Superintendent of the Fercleve Corp. thermal diffusion plant for uranium isotope separation, at Oak Ridge.

He has written numerous technical papers and is co-author of the book, "Radioisotope Techniques."

F. A. Rohrman holds the title of Principal Scientist at the Oak Ridge Institute of Nuclear Studies. Prior to this, he was Superintending Scientist and Technical Director of the U. S. Navy Mine Defense Laboratory, Panama City, Fla. Dr. Rohrman received his BA in chemical engineering from Oregon State, his master's from Minnesota and his PhD from Columbia.

He taught at Michigan College of Mining and Technology and Kansas State, was also Executive Director of the University of Colorado Engineering Experiment Station.

He served with the U. S. Army Field Artillery from 1941-45, emerging with the rank of Lt. Colonel.



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Included also is an interpreter which allows you to link together the sub-routines you want to use for the problem you are working on at the moment. The lan-

guage of the interpreter is symbolic. This makes it easy to use and eliminates the need to write a detailed program in machine language.

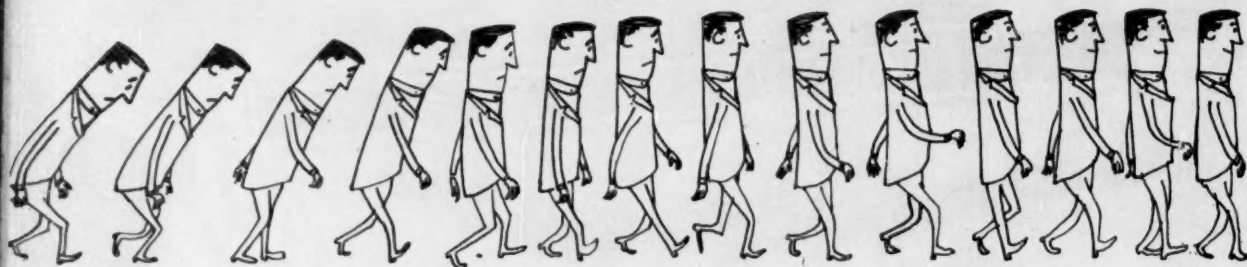
The Unit Operations Simulator is available free of charge to all users of IBM 1620 Data Processing Systems. A basic 1620 rents for just \$1,600 a month. Ask your local IBM representative to give you complete details on this versatile, low-cost engineering computer.



IBM's 1620 is a compact desk-size computer.

\*Here's what the Unit Operations Simulator does for you: **1.** Computation of equilibrium constant. **2.** Computation of temperature from a given equilibrium constant. **3.** Computation of enthalpy of a vapor and/or liquid stream. **4.** Find equilibrium constant nearest unit. **5.** Computation of temperature from a given enthalpy of a vapor and/or liquid stream. **6.** Bubble point and dew point calculations. **7.** Split one stream into two at specified ratio. **8.** Mix two streams of same phase. **9.** A mixed feed adiabatic flash calculation. **10.** Adiabatic flash. **11.** Isothermal flash. **12.** Flash to a specified quantity of vapor. **13.** Absorber/stripper calculation using Edmister short cut.

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• Lose job—tell your wife • Collect unemployment • Use government job agencies

## What It Takes to Get That New Job

If you have been the victim of an engineer cutback, or if you're just looking for a better job, check this evaluation of job-getting sources.

PETER J. BRENNAN, *Assistant Editor\**

You have been let off, laid off, permitted to resign, riffed or—bluntly and plainly—fired.

Whether you expected it or not, whether you are one of many or alone, whether it is common knowledge or a secret between you and the company, it's a shock for which you are ill-prepared. What should you do?

Go home and tell your wife.

Then check with the local office of unemployment insurance to see if you are eligible for benefits, or to find out how you can become eligible. Don't ask the company personnel department about this. Since premiums for unemployment insurance come out of its pocket, your firm may not look too kindly on your obtaining the benefits—particularly if it has given you severance pay in lieu of notice.

Don't let false pride prevent you from accepting these benefits. If you are eligible for them, take them. Looking for a job is a full-time, expensive business for which you'll need every nickel you can lay your hands on.

At the outset, you should know that it will take at least a month from the time you begin your job-seeking campaign until you get your first acceptable offer. It may take much longer. Two weeks, at least, may elapse before you get the first negative replies to your hard-thought-out, well-written letters. Discouragement will become your lot, but you must not show it.

Since one of the conditions for obtaining unemployment benefits is to be ready, willing and able to work at your profession, the unemployment bureau will attempt to find you a job through federal or state employment services—whose offices may even maintain

a special section for professional personnel. Use their help, it's free.

These agencies will interview you, arrange interviews with local companies and provide application forms for government jobs. They have booklets on resume writing, how to conduct yourself at an interview, and so on.

But they are, unfortunately, often understaffed and overloaded. Their referrals are likely to be automatic, not tailored to you. And if you decline an offer, you may lose your benefits; they may consider you no longer ready and willing to work.

However, you can't afford to overlook this source of contacts. Your first interviews are likely to come from here, long before your other efforts bear fruit. Even if nothing comes of these contacts, the practice in conducting yourself at an interview will prove invaluable later on. And after you have exhausted all your own resources, the government application forms that you laboriously filled out the first few days will begin to come home.

Your next step is to compose a resume. You don't need one for government applications, or for contacting state and federal agencies, though you will for interviews obtained through these agencies. And you must have a resume for everything else that you do—contacting private agencies, replying to ads and making "cold" contacts on your own.

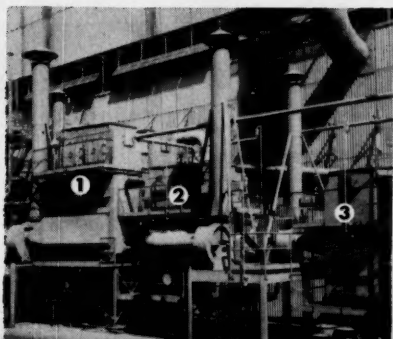
### Telling Your Life Story

Your resume should contain all that is significant about you, placed in logical order. It should be concise yet complete. Name, profession, address and phone number should come first, followed by a brief statement of what type of job you are looking for. Don't make this statement too confining; if you do, loss of flexibility may cause personnel men to reject you without further consideration.

This statement might take the form: "Position desired: responsibility in process development, production supervision or project engineering, where my experience in these fields will be valuable. Prefer coastal location but will consider others." Exact words, will depend on your own desires and experience.

\* Mr. Brennan, who wrote this article while an assistant editor of *CE*, recently joined General Atomic, La Jolla, Calif.

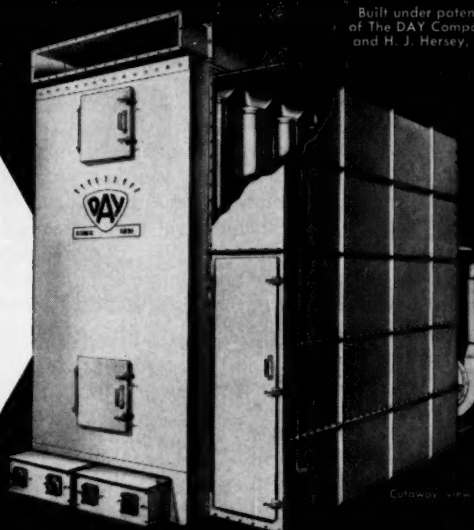




**3 DAY "AC" Dust Filters Serve  
MALLINCKRODT CHEMICAL WORKS  
URANIUM DIVISION, AEC Weldon Springs Site**

Shown at left are 3 DAY "AC" dust filters. Filters No. 1 and 2 are collecting magnesium fluoride ( $MgF_2$ ) slag dust and  $U_3O_8$  from slag grinding and similar operations. Filter No. 3, on the right, serves to filter uranium tetrafluoride ( $UF_4$ ). High filtering efficiency is an imperative requirement for an installation of this type. DAY filters meet this requirement.

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PREFERRED BY MANY  
CHEMICAL  
PLANTS**



DAY "AC" Reverse Jet Dust Filters Provide  
99.99+% Filtering Efficiencies

**More dust control for their money** is just one of the reasons why so many chemical plants own DAY "AC" Reverse Jet dust filters. The reason you get more for your money with a DAY "AC" filter is because of its super-capacity. The "AC" filter handles 10 to 20 cubic feet of air per square foot of filter cloth. This is about 5 times higher than the filtering rates of ordinary filters.

The "AC" is preferred because it is a high efficiency filter . . . with many patented features that make it one of the most advanced design Reverse Jet filters made. It's also the most proven filter of its type — proven in over 1,325 installations. **FREE Reverse Jet Dust Filter-Facts Bulletin!** Get helpful air engineering data, dust problem analysis sheet and typical equipment layouts. For your *free* copy clip and mail coupon to DAY. Request Bulletin F-75.



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☐ Please send BULLETIN F-75

☐ We have a specific dust problem that needs attention. Please contact us without cost or obligation.

NAME \_\_\_\_\_

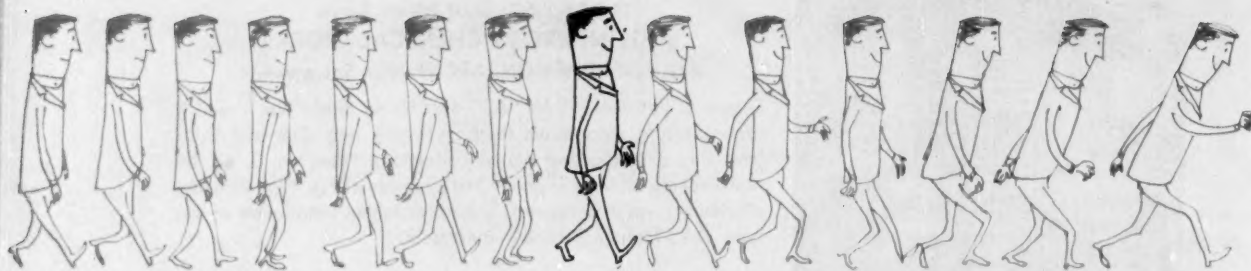
COMPANY \_\_\_\_\_

ADDRESS \_\_\_\_\_

CITY \_\_\_\_\_

STATE \_\_\_\_\_





- Compose an informative, concise resume
- Place a good ad
- Read the classified

If you are a recent graduate, with no experience, you should mention your education next. You should include where you went to college, year of degree, any pertinent special courses you took in addition to your major, and academic honors that you won. Extracurricular activities and campus offices that might indicate qualities of leadership should also be mentioned, but with modesty.

If you were first in your class, or close to it, mention that. Otherwise, don't mention class standing at all in the resume.

### Emphasize Your Experience

If it has been many years since you graduated, your actual on-the-job experience and performance is the most important part of your history and will form the bulk of your resume. The part on education, therefore, should be confined to name of schools, degrees and any academic honors. You should also mention any additional courses you've taken since leaving school.

Since your experience forms the heart of your resume, it should be prominently displayed. Start with your present job and work backwards, giving most detailed space to your most recent employment. In a sentence or two, state the inclusive dates of your employment, name, location and business of the company, and positions you have held in the organization.

Then treat each position, change in location or significant change in responsibilities as a separate job. Stress the level of responsibility for each job, number of men supervised, technical and administrative ability and knowledge required. Be sure to mention anything exceptional you did—except blunders.

The remainder of your resume should be extremely brief: patents and publications, if any; marital and draft status; citizenship; security clearance, if any; and age. There are a few "don'ts" however: never mention salary; reasons for leaving; family, political or social connections; or anything that might be construed as derogatory to you. Use your judgment here.

Four or five days will elapse before you have your supply of brand-new resumes in your hands. You should be using this time to organize the massive campaign to land your next job.

The most fertile source of worthwhile contacts will be your own advertisement in the classified section of a technical journal, particularly a weekly published by

one of the technical societies. Place such an ad at once. It will take anywhere from two weeks to six weeks before it actually appears in print. If you are a member of a technical society, you can often place the ad at no charge, but even if you must pay, it's well worth the cost.

The advantage of putting your ad in the technical journal is that only companies that are interested in you will reply to it. These are the highest quality contacts that you are likely to get.

An advertisement much like the following should be sufficient, depending on your background, of course:

Chemical engineer, age 26, married. Four years experience process development, plant engineering, plant startup and production including supervision. Seeks responsible position in production supervision or project engineering. Will relocate.

This particular ad, by the way, drew ten replies, four interviews and three offers, in the depths of the '58 recession, a much higher average than any other single source of contacts.

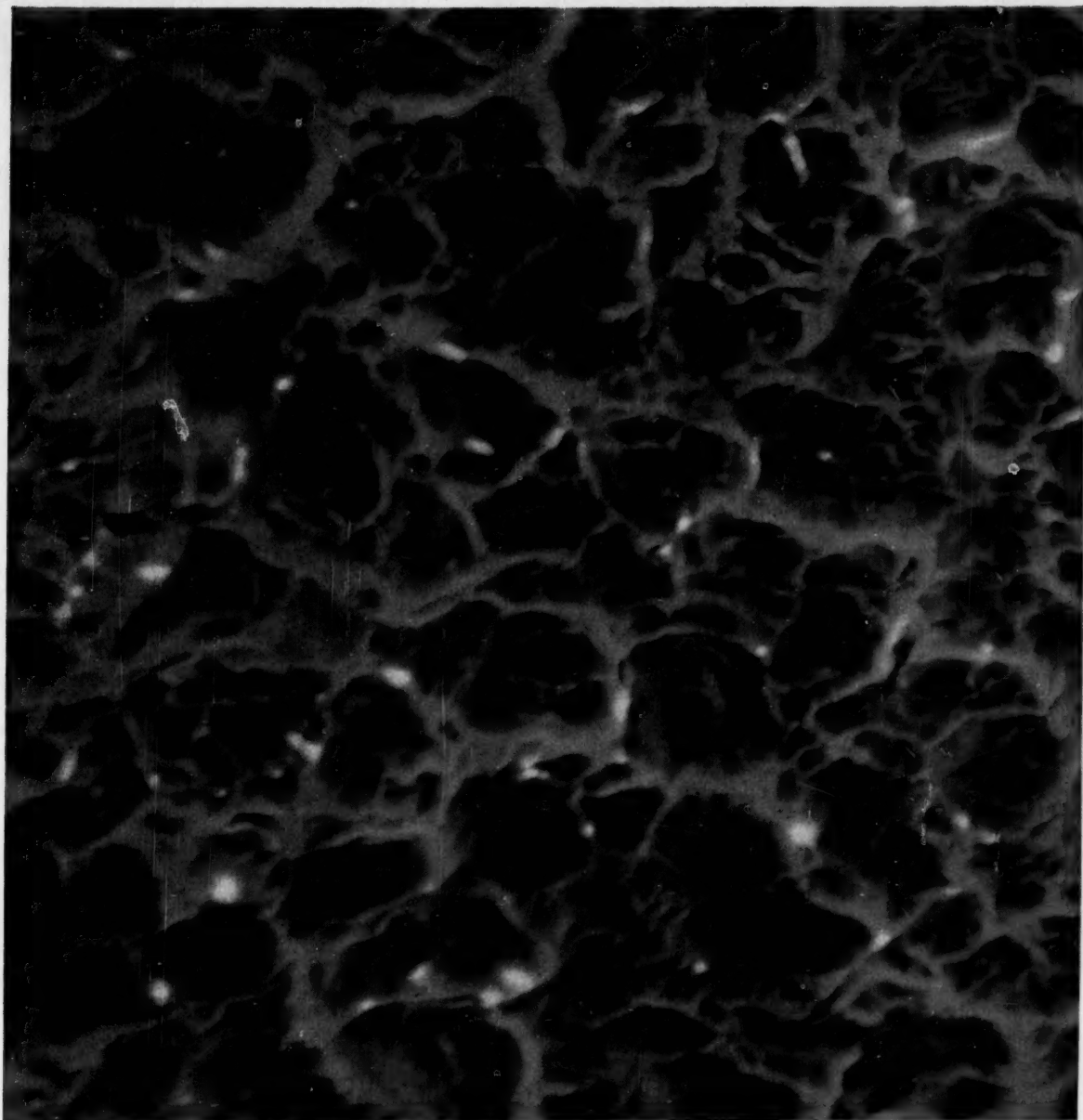
During your campaign, you will contact a minimum of 75 companies, and perhaps many more than that. For the sake of efficiency in keeping track of correspondence, and for measuring efficacy of your sources, you should make up a form for each source—one for your own ad, one for "cold" contacts, one for each employment agency, one each for open and blind ads.

### Keep Good Records

On these forms, record the name and address of each company and the name of the individual with whom you correspond. Record dates of all incoming and outgoing correspondence (including date you submit application), and whether or not there was an interview.

The one source of contacts immediately available to you is the classified section of technical journals and newspapers, both local and national. Competition is likely to be great, however, and only a few of the ads will be even remotely applicable to your experience and desires.

Help-wanted advertisements in both the technical press and the newspapers fall into two categories: open ads, in which the company identifies itself, and blind ads, which give only a box number. You should reply to all applicable open ads in both media, and to blind ads in the technical press. But don't waste your time with blind ads in the newspapers.

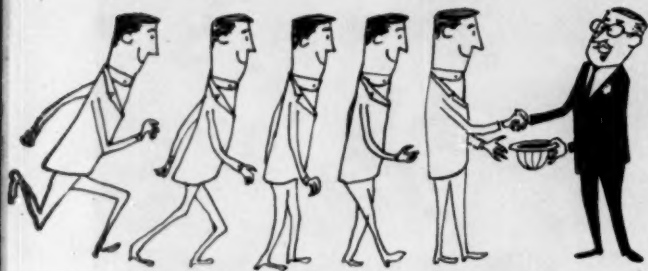


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• Choose a job agency • Get that new job!

You can start in immediately by typing up individual resumes and cover letters for each ad. You can tailor each resume to the job you are seeking. But in the long run, you are going to have to use your identical, reproduced resumes for all your contacts. Then your cover letter must be fitted to the job and company.

Try to find out all that you can about a company before writing to it. If possible, get the name of your prospective supervisor or at least that of the personnel manager. Then, in your cover letter, amplify such details in your background and experience that you feel will be most interesting to this particular company and will, you hope, give you an edge on your competition.

If your letter and resume are well typed on the best bond paper and are absolutely free of errors and erasures—yet, obviously your own work—you will already have an edge. You would be surprised how many people try to get a job with a letter whose appearance would have had them fired in the first place.

Your least rewarding source of leads will be your "cold" contacts—companies that you write to with no hope other than that they just might have something for you. You should draw up a list of such companies from personal knowledge, from chemical industry catalogs, from standard references such as Moody's or Standard and Poor's, and from special career supplements put out by various technical societies.

The percentage of replies to your cold contacts will be quite high, but mostly negative. Don't let this discourage you; the more letters you send out, the greater your chances of getting an interview and, eventually, a job.

**Where Others Can Help You**

Choose employment agencies carefully. Some of them can waste a great deal of your time—in filling out forms and being sent off on interviews in which you haven't the slightest interest. Never deal with an agency that wants you to pay a fee. These days in the engineering field, nearly all companies pay the fee. Unless you're really desperate, you will not want to go with one that won't—it wouldn't bode well for your future.

One- and two-man agencies are generally your best bet. It seems that an agency's efforts on your behalf tend to be in inverse ratio to its size. Try to find an agency that will help you with your resume and make up capsule resumes that are circulated to a large list

of companies. Ask your friends about their experiences, and follow their guidance.

In any case, to reduce the chances of duplication, don't go to more than three or four agencies.

Technical society conventions and meetings can be an excellent source of contacts because company recruiters abound at some of them. If the meeting is in your locality, you would be foolish not to attend. But even if it is some distance away, it might still be well worth your time and money to pay your own way there.

Some of the societies also maintain permanent employment services for their members, in addition to those at conventions and the free advertising privileges.

All that we have said has been aimed at getting you an interview, and it's there that you will win or lose the job. Others have written in these pages on interview technique.\*

Finally, reply to all correspondence. No one likes to have his letters go unanswered, and personnel people are no exception. Reply even to letters of rejection, because companies *will* keep your application on file. After awhile, follow up with an inquiry referring to previous correspondence. Something might open up.

The most important letter that you can write is one of thanks immediately following an interview. Thank people for their kindness to you, and reiterate your great desire to work for that company. This letter may be the clincher that gets you the job. It is really amazing, though, how many job-seekers neglect this simple courtesy and thereby lose out to someone with better manners.

Good luck!

\*"Get a Job From the Man Who Owns One: The Interviewer," *Chem. Eng.*, Dec. 15, 1958, pp. 184-186.

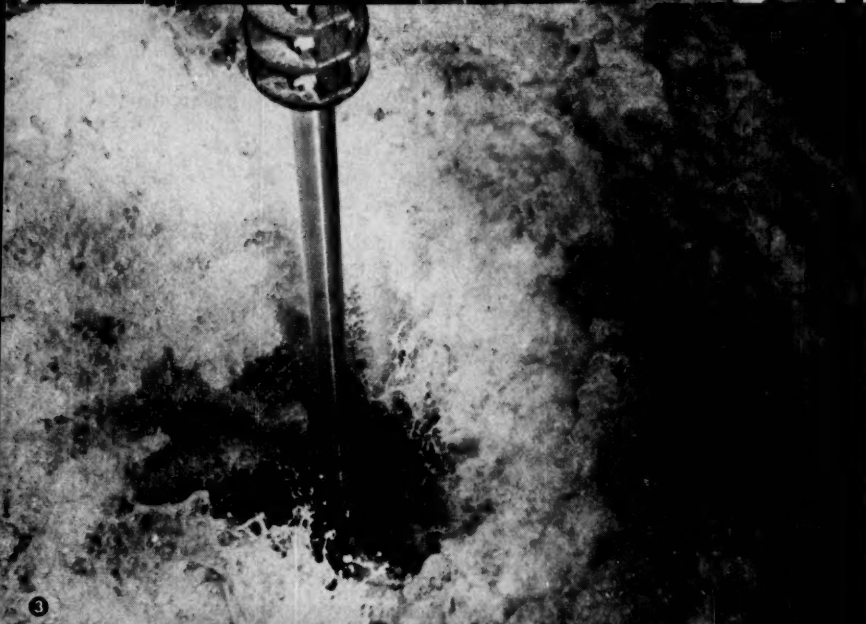
Meet  
the  
Author



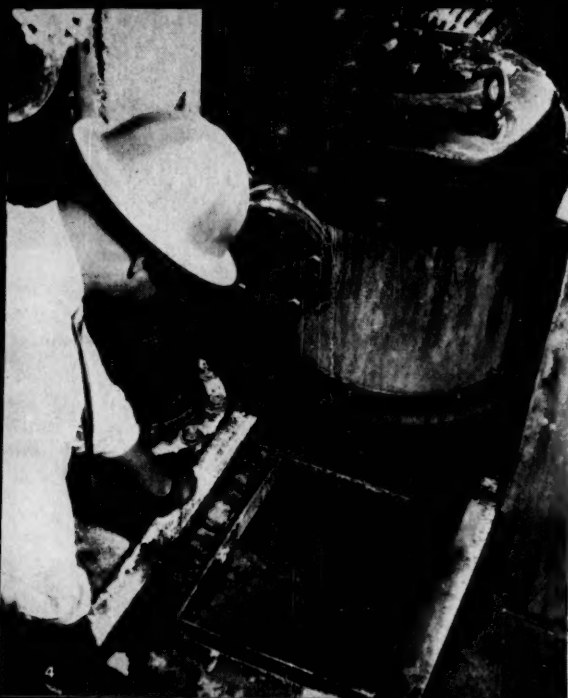
PETER J. BRENNAN has recently left the staff of Chemical Engineering to join General Atomic Div. of General Dynamics Corp. Before coming to CE, Mr. Brennan had discharged engineering responsibilities in the paper, food, electrochemical and nuclear industries. Born in Dublin, he became a citizen of the U. S. and took his B.Ch.E. at Catholic University. Mr. Brennan, who edited the Operation & Maintenance department of CE, is a member of AIChE, ANS, ACS and the Nuclear Energy Writers Assn. Married, he is the father of two boys and a girl.



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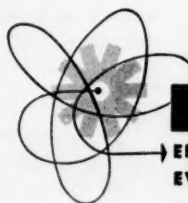
**At FMC, Nettco Mixers** are used for: agitating, mixing, reacting, suspending solids, blending miscible liquids, circulating, heat transfer and continuous treating. The results: Complete mixes, close product control and minimum downtime.

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# Use These One-Step Equations to Find Reboiler and Condenser Duty

*When McCabe-Theile assumptions apply, the equations developed here give heat into and out of fractionators.*

★ Winner of the December Contest  
JACK L. BECKNER, Texas Technical College, Lubbock, Tex.

When the simplifying assumptions in McCabe-Thiele-type solutions can be made for a system, the variable operating conditions are related to condenser duty  $Q_c$  and reboiler duty  $Q_r$  by the equations derived here.

The conditions that are to be fixed are usually these: feed composition  $x_F$ ; distillate-product composition  $x_D$  and bottom-product composition  $x_B$ .

The variable operating conditions are usually: reflux rate,  $R$ , expressed as  $L/D$ ; feed rate  $F$ ; and a function of feed enthalpy,  $q$ , defined by Treybal as

$$q = \frac{L' - L}{F} = \frac{H_v - h_F}{H_v - h_L}$$

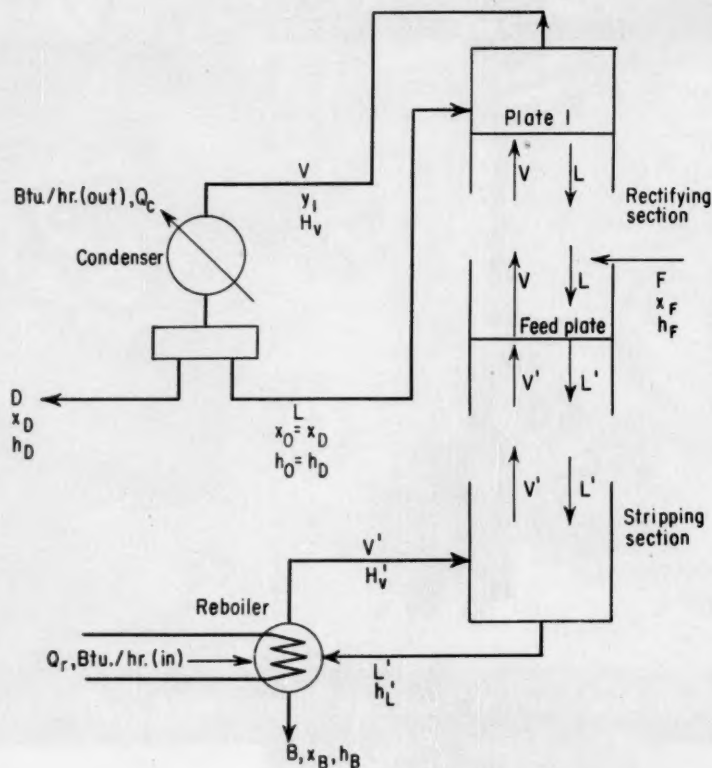
This  $q$  is the amount of heat required to raise the feed from the incoming condition (enthalpy  $h_F$ ) to a saturated vapor (enthalpy  $H_v$ ), divided by the latent heat of vaporization ( $h_L$  is the enthalpy of the feed at the bubble point). Or,  $q$  is the quantity of saturated liquid produced on the feed plate per unit quantity of feed introduced.

► **Reboiler Duty**—If we let  $Q_r$  be the heat actually transferred to the solution in the reboiler, then the actual reboiler duty will be  $Q_r$  plus heat lost in transfer. This extra heat is determined by the ordinary calculations. Our  $Q_r$  will be  $Q_r = V'(\Delta H_v)$  where  $\Delta H_v$  is the latent heat of vaporization of  $V'$  (see sketch).

By a material balance around the feed plate,

$$F + L + V' = V + L' \quad (1)$$

$$\text{or } 1 + \frac{V' - V}{F} = \frac{L' - L}{F} = q$$



$$\text{solving for } V': V' = V + F(q - 1) \quad (2)$$

Now, it is desirable to express  $V$  in terms of the reflux ratio,  $R = L/D$ . By a material balance around the condenser,  $V = L + D$  or

$$V = D(R + 1) \quad (3)$$

$D$  may be expressed in terms of  $F$  and the fixed conditions by a material balance around the whole column:  $F = D + B$ , and for one component,

$$x_F F = x_D D + x_B (F - D) \text{ from which}$$

$$D = F \frac{x_F - x_B}{x_D - x_B} \quad (4)$$

We will let  $C$  denote the fraction in Eq. 4. Then,  $D = FC$ . Substitut-

ing Eq. 4 into Eq. 3 and eliminating  $V$  between (3) and (2):

$$V' = FC(R + 1) + F(q - 1)$$

and from our definition of  $Q_r$ :

$$Q_r = F(CR + q)\Delta H_v \quad (5)$$

which is the desired result.

► **Condenser Duty**—If the heat removed by the condenser  $Q_c$  produces a condensate at the bubble point, the condenser duty will be:

$$Q_c = V\Delta H_v$$

then an expression for  $Q_c$  is derived from Eq. 3 by substituting for  $D$  from Eq. 4:

$$V = FC(R + 1)$$

so that

$$Q_c = F(R + 1)C\Delta H_v \quad (6)$$

## Train yourself and others in supervisory techniques for professional advancement

Popular thinking on any subject is often like a pendulum, swinging forward in sheer exhilaration over an exciting idea, then backward to a cynical attitude against it. Years ago, health columnists extolled the nutritive qualities of spinach. Shortly thereafter, it was equally popular to decry spinach as an overglamorized weed.

This vacillation springs from the efforts of spokesmen to capture interest, and the tendency of many people, like wild creatures in the forest, to give attention to whatever is moving regardless of the direction. That is why it sometimes seems that the more preposterous an idea the more credence it receives.

World War II, with its demands for hundreds of thousands of leaders to be developed quickly, accelerated the concept of training men in human relations. Many veterans tried, after the war, to apply the principles to industry. Supervisor and management development became extremely popular. Some of these programs naturally fell short of expectations, and there are always detractors — ready to display their intellectual brilliance by speaking cynically of *all* types of human relations training. Real progress in supervisory methods has, therefore, been slow.

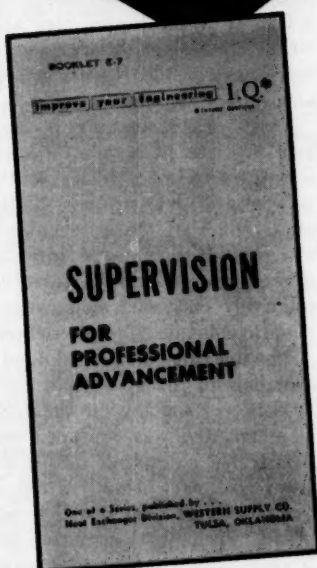
Supervisory personnel, continually aware of the intrinsic values of human relations, are

the key to uninterrupted production, completion of projects successfully and on time, for they forge the links in the productive chain solidly together.

Your management is interested not only in the creative, bold steps you would take into unknown solutions to problems, but also in how quickly and productively (profitably) you can put these ideas into practical application. When the solution, or idea, leaves your desk and starts down the long line of being put into practice, supervisors throughout that chain of action and their relationships with those about them — will determine to a great extent whether their individual components will function properly or whether a project will bog down under the weight of misunderstanding and apathy.

It signals to the engineer in charge, therefore, the importance of maintaining good supervisory practices throughout the various departments through which the original concept must be translated. It means a thorough understanding of human relations yourself, and the ability to communicate this understanding and appreciation to the supervisory personnel under you. This can and probably must be done both by individual contact with your supervisors and/or by conducting actual courses of study on the subject.

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... the foregoing paragraphs are a direct quotation from another of Western's personal-professional-development series, copies of which are available upon request at no charge.

Western's conviction about the importance of competent supervisors as an adjunct to efficient engineering work is founded upon direct observation in our own plant, where trained supervisors contribute greatly to the manufacture of heat exchangers of the highest quality, and where personal attention to detail is their watchword. We invite your inquiry when heat transfer problems arise.



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► **Example**—Consider the system  $\text{CS}_2$  and  $\text{CCl}_4$  at one atmosphere for which data is available from Ref. 1, page 574.

The feed contains 30.0 mole %  $\text{CS}_2$  at 80 F. and is to be separated into a distillate product containing 95.0 mole %  $\text{CS}_2$  and a bottom product containing 5.0 mole %  $\text{CS}_2$ . Arbitrary operating conditions will be chosen for illustration:  $F = 100$  moles/hr.,  $R = 3.0$ .

The latent heat of vaporization

for this system is calculated to be 2,810 Btu./mole, and  $q$  is determined to be 1.6. By substituting known quantities,  $C$  is evaluated as:

$$C = \frac{0.300 - 0.050}{0.950 - 0.050} = 0.278$$

The reboiler duty is

$$Q_r = 100 [(0.278 \times 3.0) + 1.6] 2,810 = 6.84 \times 10^6 \text{ Btu./hr.}$$

The condenser duty is

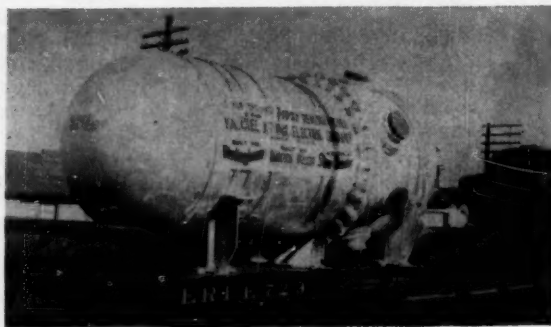
$$Q_c = 100 (3.0 + 1.0) (0.278) 2,810 = 3.12 \times 10^6 \text{ Btu./hr.}$$

These are the heat quantities that

must be transferred into and out of the solutions. If heat transfer coefficients of the reboiler and condenser are known, then the actual heat supplied and removed can be calculated.

#### References

1. "Chemical Engineers' Handbook," J. H. Perry, 3rd ed., McGraw-Hill, p. 590, 1950.
2. Treybal, R. E., "Mass Transfer Operations," McGraw-Hill, p. 295, 1955.



## REACTOR VESSELS CLEANED WITH NITRIC "VAPOR"

C. M. LOUCKS,  
Consulting Chemist, Westlake, Ohio  
W. B. BROWN,  
Hydrosol Systems, Inc., Bedford, Ohio

Our problem was to remove a film of iron oxide and metallic iron from the 304-stainless-clad interior surfaces of two new atomic reactor vessels to provide a passive, rust-free surface.

The vessels were 9½ ft. by 32 ft.

and 9 ft. by 26 ft., inside dimensions. The internals and permanent heads were not in place.

The specifications called for the use of nitric acid for iron removal. The surfaces had been blasted with Alundum grit and looked essentially clean but there was metallic iron present on the surfaces, as revealed by the standard copper sulfate test.

Filling the vessels with nitric acid seemed neither practicable nor

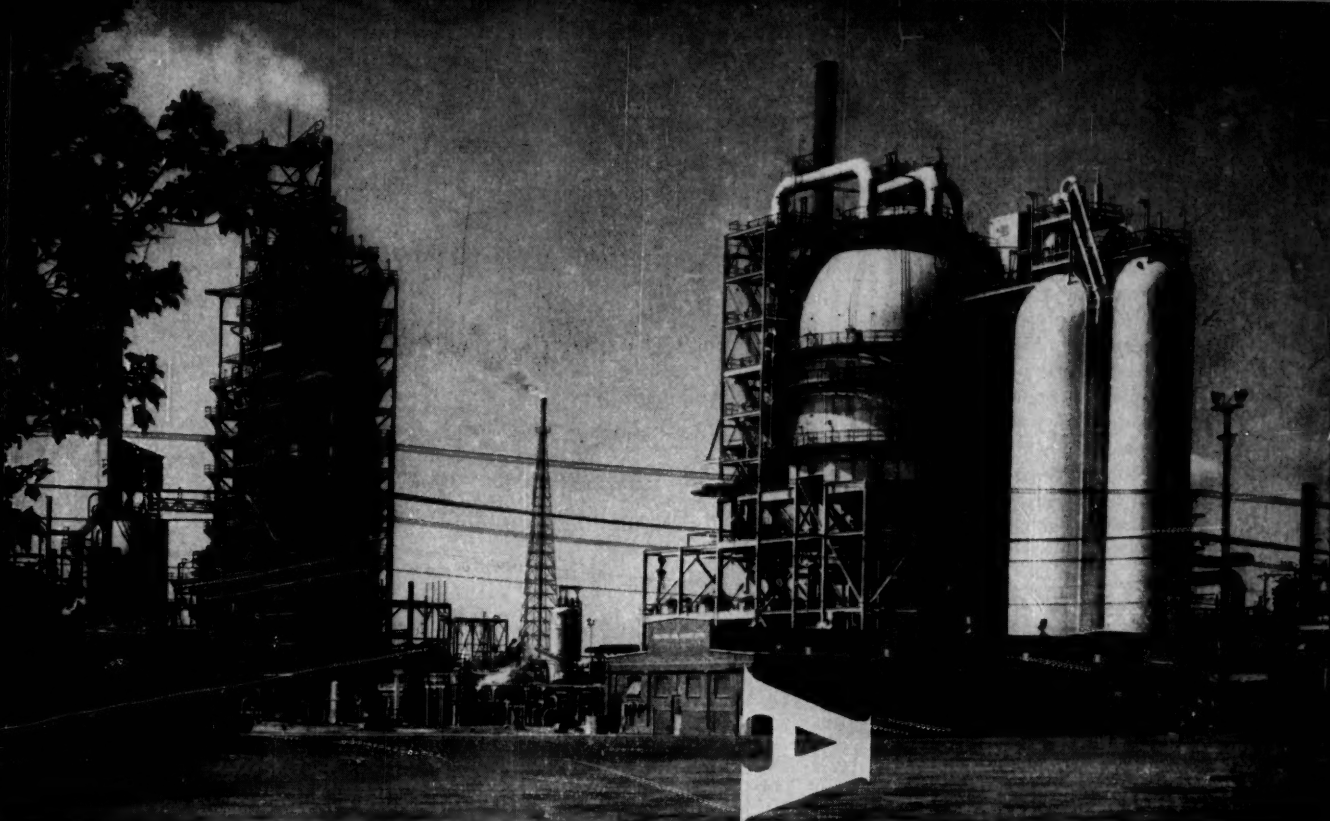
economical. And, although smaller vessels can be cleaned by spraying the acid over the surfaces, a rather elaborate spray system would be required to apply liquid over all internal surfaces of these two vessels. So, it was decided to use a "vapor phase" technique.

Vapor-phase cleaning is a common practice with volatile organic solvents and, since nitric acid is a volatile acid, why not use this technique to clean these reactors? If nitric acid vapor were introduced into the vessel, with the vessel walls relatively cool, the acid could not avoid condensing on all surfaces.

The openings were stoppered, except one on the lowest part of the vessels as they lay on their sides. That opening was equipped with a plastic leg extending into a stainless steel pan below. Nitric acid "vapor" was provided by taking steam from a locomotive crane

	Vessel I	Vessel II
Inside dimensions.....	9 ft. x 26 ft.	9½ x 32
Weight (stripped).....	110 tons	180 tons
Gal. of 42° Be. nitric used.....	78*	52
Time of acid exposure.....	3½ hr.	3 hr.
Volume % of condensed acid.....	30%	20%
Dissolved Fe in first sample.....	0.10%	0.33%
Second sample, ½ hr. later.....	0.01%	0.02%

\* The larger volume for the smaller vessel was experimental. It is believed that a smaller quantity would have accomplished the same result.



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boiler, adding to it 42° Be. technical-grade nitric, and introducing the vapor through an open-end stainless steel pipe extending a short distance inside the vessel. The acid was added to the steam by means of a small Eco stainless steel Teflon gear pump that would handle the 1-2 quarts per min. required.

Samples of condensed acid, taken at the drain leg, showed most of the iron removed in the first few minutes of exposure. When it was decided to discontinue the acid, the supply was shut off and the steam was continued to rinse the surfaces. Observations at the drain leg showed when all the acid had been removed and, when a man could enter, the inside was hosed down with demineralized water. While the mass of metal was still warm, ports were opened to allow ventilation and the surfaces quickly dried.

After the cleaning, the copper sulfate test showed the surfaces to be entirely free of metallic iron. Some of the engineering data that may be of interest is shown in the table. Since this was the first time this technique had been used, as far as we know, some experimenting was done. The amounts of material, times of exposure, etc., should not, therefore, be considered the optimum or most satisfactory values.

The authors wish to thank the Babcock and Wilcox Co. for permission to publish this material.

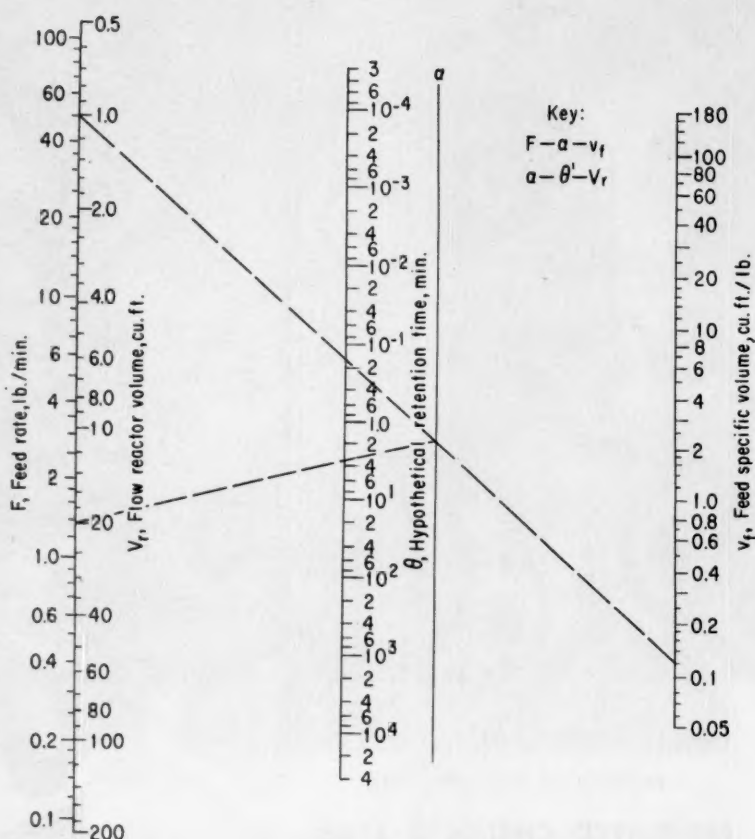
## TEST YOUR CEQ

ROBERT LEMLICH

This is not an original problem but one I picked up a number of years ago from one of my own mathematics teachers. It is one of my favorites.

Given  $PV = KT$  for a fixed mass of gas, it is a simple matter to prove Boyle's Law and Charles' Law. However, try the converse—that is, starting with Boyle's and Charles' Laws, prove that  $PV = KT$  is the unique over-all equation.

(Answer on page 172)



## NOMOGRAPH GIVES REACTION TIME OR REACTOR SIZE

H. B. KENDALL,  
Assoc. Prof. of Chem. Eng.  
Ohio University

A useful concept in estimating the size of tubular flow reactor required to perform a desired conversion at a given feed rate is the "space velocity" ( $SV$ ). The space velocity has the units of reciprocal time and is defined:

$$SV = \frac{Fv_r}{V_r} \quad (1)$$

where  $F$  is the feed rate, mass (or moles)/unit time;  $v_r$  is the specific volume of the feed, vol./unit mass;  $V_r$  is the volume of tubular flow re-

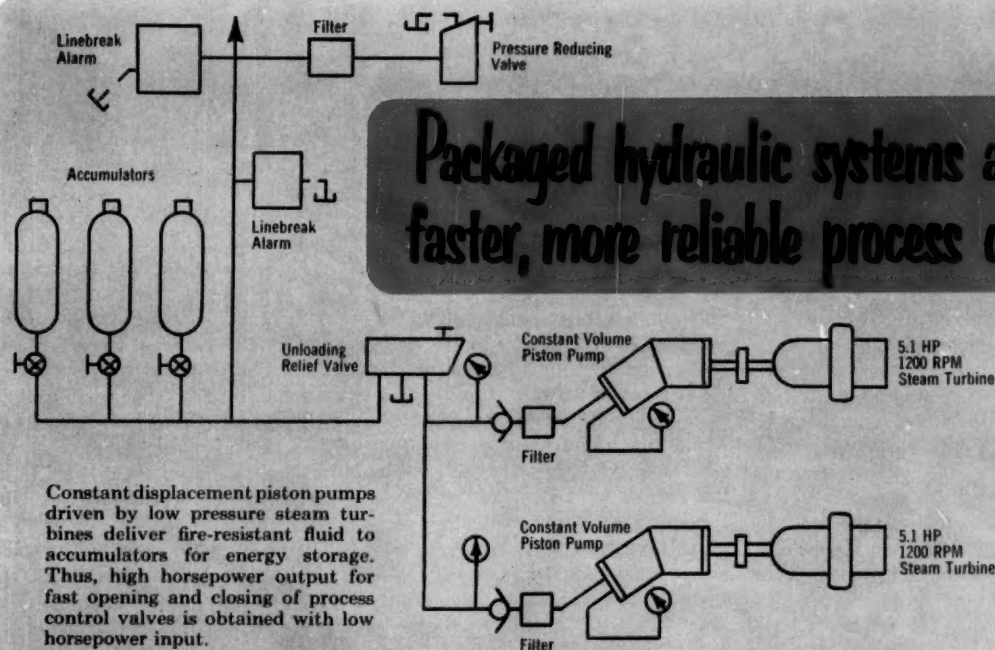
actor for the desired conversion, vol.;  $SV$  is the space velocity, time<sup>-1</sup>.

As  $SV$  increases, so does the ease of accomplishing the desired reaction. That is, a large value of  $SV$  indicates that either a small reactor or a high feed rate can be used for the conversion.

It should be possible to use the reciprocal of  $SV$  for estimating the retention time or the reaction time required for a desired conversion in a given reactor. This hypothetical retention time  $\theta'$  is defined:

$$\theta' = \frac{1}{SV} = \frac{V_r}{Fv_r} \quad (2)$$

An equally interesting use of Eq.



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2 is in estimating the reactor volume  $V_r$  if the feed rate, feed specific volume and retention time required for the given conversion are known.

Caution should be exercised in trying to apply Eq. 2 to gaseous reactions. Changes in temperature, pressure or moles of reaction mixture will change the specific volume  $v$  of the mixture in the reactor so that it is no longer equal to  $v_f$ . Under these conditions,  $\theta'$  may have little relation to actual retention time. However, if a reasonable estimate can be made of the specific volume of the feed, and if there is no appreciable change in reaction conditions or in number of moles passing through the reactor—or if a reasonable average value of  $v$  can be estimated—then the value of  $\theta'$  from Eq. 2 should have some validity.

The accompanying nomograph was designed as an aid in solving Eq. 2. With this chart, it is possible to estimate very rapidly either the time required for a reaction in a given reactor or the reactor volume needed when the retention

time for completion is known.

The following examples illustrate the use of the nomograph:

1. In a tubular flow reactor having a volume of 20 cu. ft., the desired degree of conversion is obtained when the feed rate is 50 lb./min. If the specific volume of the feed is 0.12 cu. ft./lb., what is the residence time in the reactor?

On the nomograph, connect  $F = 50$  to  $v_f = 0.12$  with a straight line. From the intersection of this line with the reference line  $a$ , draw a line to  $V_r = 20$ . Read residence time,  $\theta' = 3.4$  min.

2. It is desired to estimate the volume of a tubular flow reactor to bring about the given conversion when the time in the reactor is to be limited to 0.1 min. and when the feed rate and specific volume will be 0.6 lb./min. and 9.0 cu. ft./min. and 9.0 cu. ft./lb., respectively.

Connect  $F = 0.6$  and  $v_f = 9.0$  with a straight line. At the intersection with  $a$ , construct a line through  $\theta' = 0.1$  to the  $V_r$  axis. Read reactor volume,  $V_r = 0.54$  cu. ft.

air flame. The hydrogen can be produced locally by the action of zinc with an acid.

When we did this operation in our plant, it often happened that the weld was blackened and unsatisfactory. The cause was found to be a few ppm. of hydrogen sulfide in the hydrogen, as detected with lead acetate paper. The sulfur may have originated from the zinc or acid used, or from the vulcanized rubber tubes leading from the generator.

To solve the problem, we passed the hydrogen through a glass tube filled with soda-lime, which was situated near the burner. The soda-lime darkened during use but the hydrogen produced was pure and the welding was satisfactory.

The sketch shows the filter we used. It consists of a glass tube filled with 100 gm. of soda-lime, its capacity being 30-35 litres of hydrogen sulfide. The filter is refilled with fresh soda-lime as required. Also, it is advisable to use only sulfur-free plastic tubing.

## Zinc Dust Improves Polyethylene Coatings

N. E. WILSON

Dempster Mill Manufacturing Co.  
Beatrice, Nebr.

Here is an idea for a corrosion-resistant coating that has worked out quite well on small items in our laboratory.

Polyethylene dispersions make good coatings for metal objects, but they leave something to be desired as dip or slush coatings. Buildup is poor or nonexistent on the edges. The sharper the edge, the poorer the buildup is in relation to the rest of the coating.

For example, we needed a coating for water tanks with lap-jointed side sheets of 14-gage steel. The exposed, freshly cut edges became a weak point in the coating.

We solved the problem by adding a quantity of finely divided zinc dust to the dispersion. The best results are with a 1:1 ratio of zinc dust to polyethylene powder but we have gone as high as a ratio of 2:1.

## References

1. Davis, D. S., "Nomography and Empirical Equations," Reinhold, pp. 151-162, 1955.
2. Smith, J. M., "Chemical Engineering Kinetics," McGraw-Hill, pp. 99-101, 1956.

## COMING MARCH 20:

### Magnetic Tags Identify Stored Material

By C. F. Bean

January Contest Winner

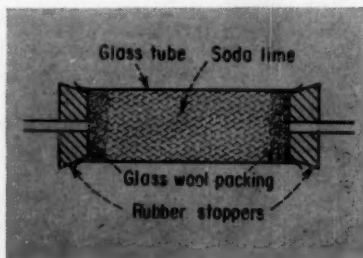
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Articles should interest chemical engineers in development, design or production. They may deal with useful methods, data, calculations. Address: Plant Notebook Editor, *Chemical Engineering*, 330 W. 42 St., New York 36.



## Filter Prevents Blackened Lead Welds

S. HAREL

Fertilizers and Chemicals Ltd.,  
Haifa, Israel

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rine ... or hypochlorites ... or urea ... titanium merits serious study. TMCA can help you locate the fabricator best qualified for your specific need ... the economies can be yours for the asking.

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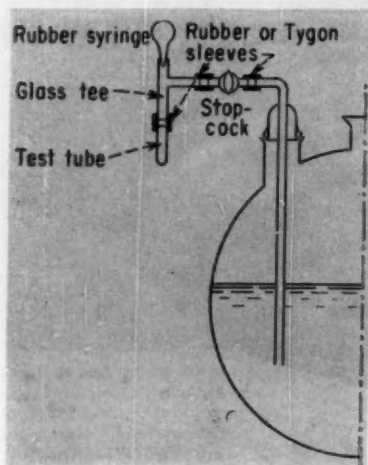
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The same coating procedure is used as with a normal polyethylene dispersion and the final result, although somewhat less durable, is a good buildup on sharp edges and corners. Higher zinc-dust ratios seem to give a measure of galvanic protection, as in galvanizing. For tank interiors, durability is good on pickled, hot-rolled steel.

Coating adhesion of the high-density polyethylene dispersions is also enhanced by the zinc filler.



## Device Takes Samples During Lab Reaction

R. J. JOHNSON  
B. F. Goodrich Chemical Co.,  
Avon Lake, Ohio

It is often desirable to withdraw one or more samples for analysis during the course of a lab reaction. The sampling device depicted here is easily assembled from equipment readily available in most labs.

When the sample is to be withdrawn, the stopcock is opened and the small test tube is slipped onto the bottom leg of the glass tee. The bulb of the syringe is squeezed and the tip is inserted into the upper leg of the tee and pushed in far enough to make an air-tight seal. When the bulb is released, the sample is drawn up the tube and drops into the small test tube. The stopcock is then closed and the test tube removed.

IV	I	3	3/5	3/5	3/5
III	II			6	6/6

## Simple Method Proves Multiplication

G. J. CARAS  
Process Engineer, Thiokol Chemical Corp., Huntsville, Ala.

Most of us were taught in school that the only way to check a multiplication is to divide the product by the multiplier, and if the quotient is equal to the multiplicand, the multiplication is correct. Here is a much easier and quicker way to check a multiplication:

Suppose you want to check the following:

$$2,856 \times 23 = 65,688$$

where 2,856 is the multiplicand; 23 the multiplier; 65,688 the product.

First, make a cross with the quadrants numbered as shown. Second, add the digits of the multiplicand and continue to add the digits of the resulting sum until a

one-digit number is obtained:

$$\begin{array}{r} 2 + 8 + 5 + 6 = 21 \\ 2 + 1 = 3 \end{array}$$

Put the 3 in the fourth quadrant.

Next, add the digits of the multiplier and put the resulting one-digit number in the first quadrant:

$$2 + 3 = 5$$

For the fourth step, multiply the number in Quadrant IV by that in Quadrant I and, by adding the digits of the product, reduce it to a one-digit number.

$$\begin{array}{r} 3 \times 5 = 15 \\ 1 + 5 = 6 \end{array}$$

Place the 6 in Quadrant II.

Finally, add the digits of the product of the original multiplication and reduce the sum to a one-digit number:

$$\begin{array}{r} 6 + 5 + 6 + 8 + 8 = 33 \\ 3 + 3 = 6 \end{array}$$

Place this number in Quadrant III. If the numbers of Quadrants II and III are the same, the multiplication is correct.

This method may seem a little complicated, but with a little practice, it can be mastered and used very rapidly. It is particularly useful where sliderule accuracy is unacceptable.

### Answer to "Test Your CEQ"

Boyle's Law states that for a fixed temperature,  $PV$  is a constant. The "constant," however, varies with temperature so that, really,

$$PV = f(T) \quad (1)$$

According to Charles' Law, for a fixed pressure,  $V/T$  is a constant. Here, the "constant" varies with pressure so that

$$V/T = \phi(P) \quad (2)$$

Dividing Eq. 1 by Eq. 2, gives

$$PT = f(T)/\phi(P) \quad (3)$$

Separating variables, we have

$$P\phi(P) = f(T)/T = K \quad (4)$$

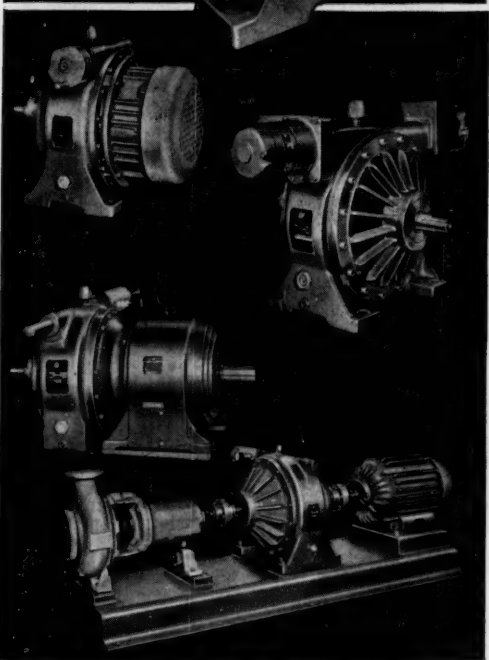
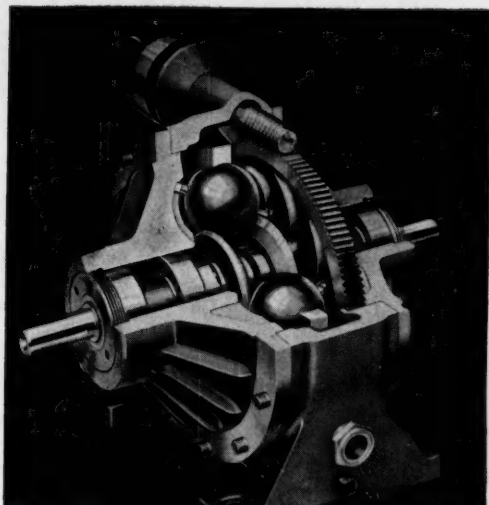
Now, the left-hand side of the above relationship is a function of  $P$  only and the right-hand side is a function of  $T$  only. Furthermore, values can be chosen for  $P$  and  $T$  independently of each other. The only way that this is possible is for both sides to equal a constant. (This is the same reasoning that appears in the technique of separation of variables applied to reduce certain partial differential equations to total differential equations.) Thus,

$$P\phi(P) = f(T)/T = K \quad (5)$$

Substituting for  $\phi(P)$  from Eq. 2, or for  $f(T)$  from Eq. 1, yields

$$PV/T = K \quad (6)$$

$$\text{or, } PV = KT \quad (7)$$



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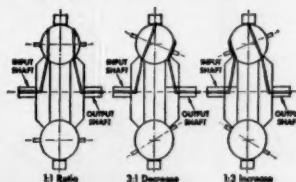
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## No. 49: Cost-Capacity Data III

More data on the exponential relationship of chemical plant construction costs with capacity.

JONAS M. BERK, JOHN E. HASELBARTH  
Houston, Tex.

Continuing our presentation of Cost/Capacity data, we show graphs for two industrial gases and three alcohols. Previous data in this series appeared in Cost File No. 46 (Dec. 12, 1960, p. 172) and No. 48, (Jan. 23, 1961, p. 161).

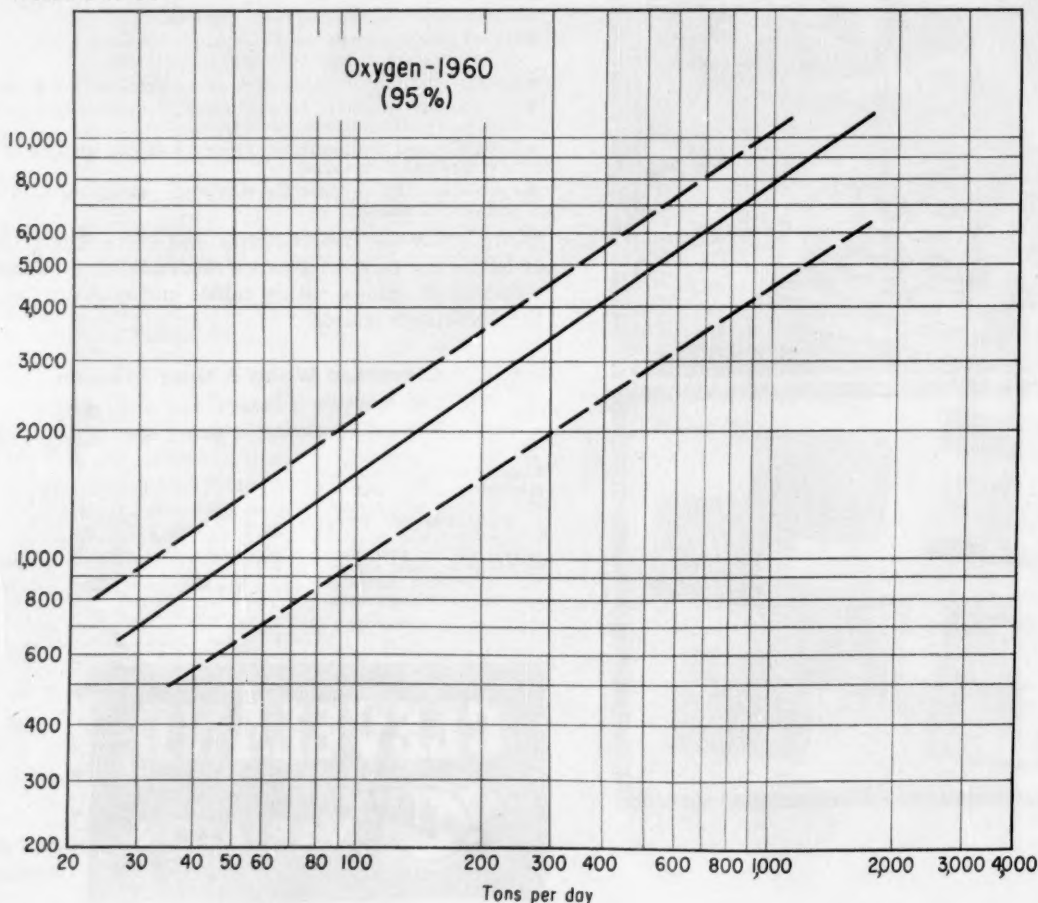
In the case of oxygen, there was sufficient information available to plot costs for the three categories of

construction outlined in Cost File 29 (Apr. 18, 1960, p. 194.) These three categories include a completely new "grass roots" plant, a new producing unit within a previously developed plant site, and an enlargement of an existing unit.

Capacity exponential factors (or "power" factors), for the graphed processes are: oxygen, 0.70; acetylene, 0.73; methanol, 0.83; butyl alcohol, 0.55; and isopropyl alcohol, 0.60. Use of these exponential factors was explained in *Chem. Eng.*, Mar. 7, 1960, p. 116.

Data are for the third quarter of 1960.

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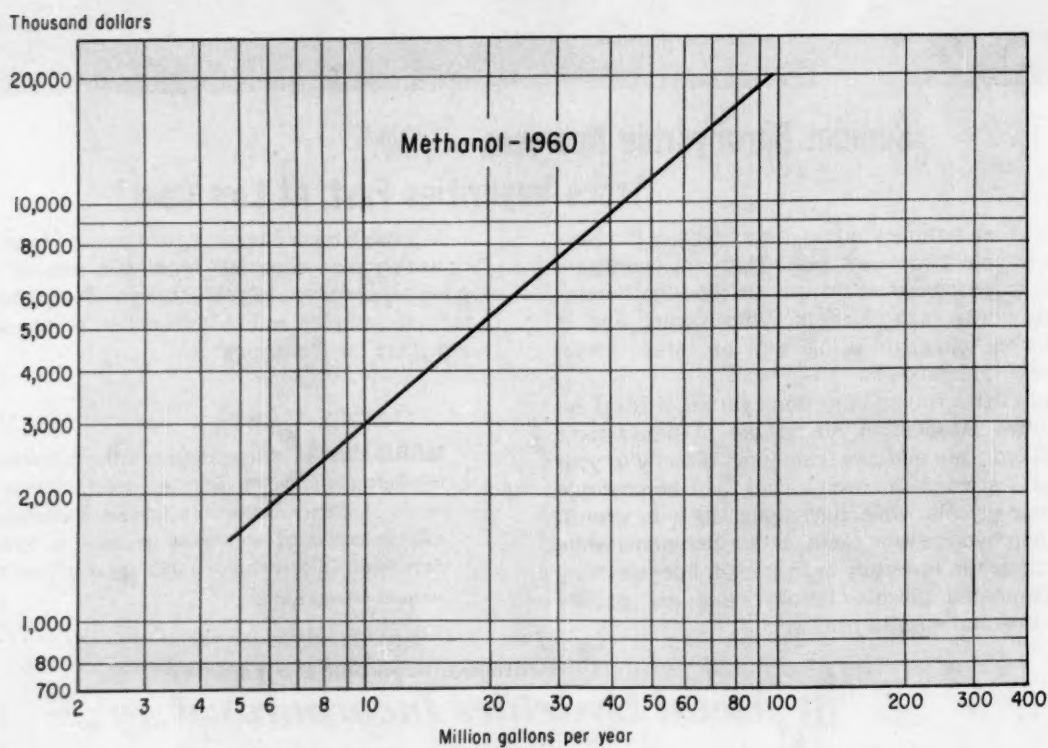
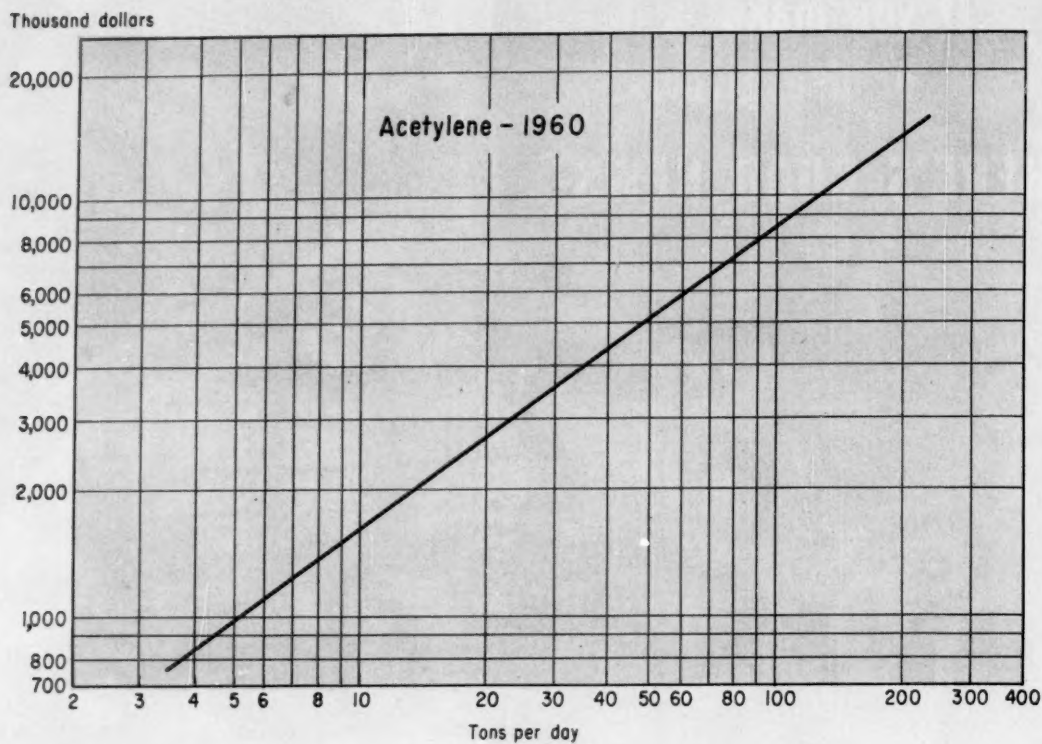


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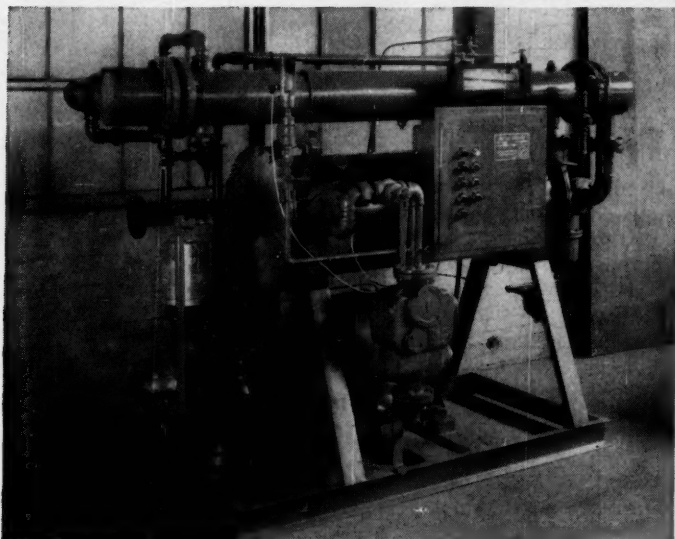
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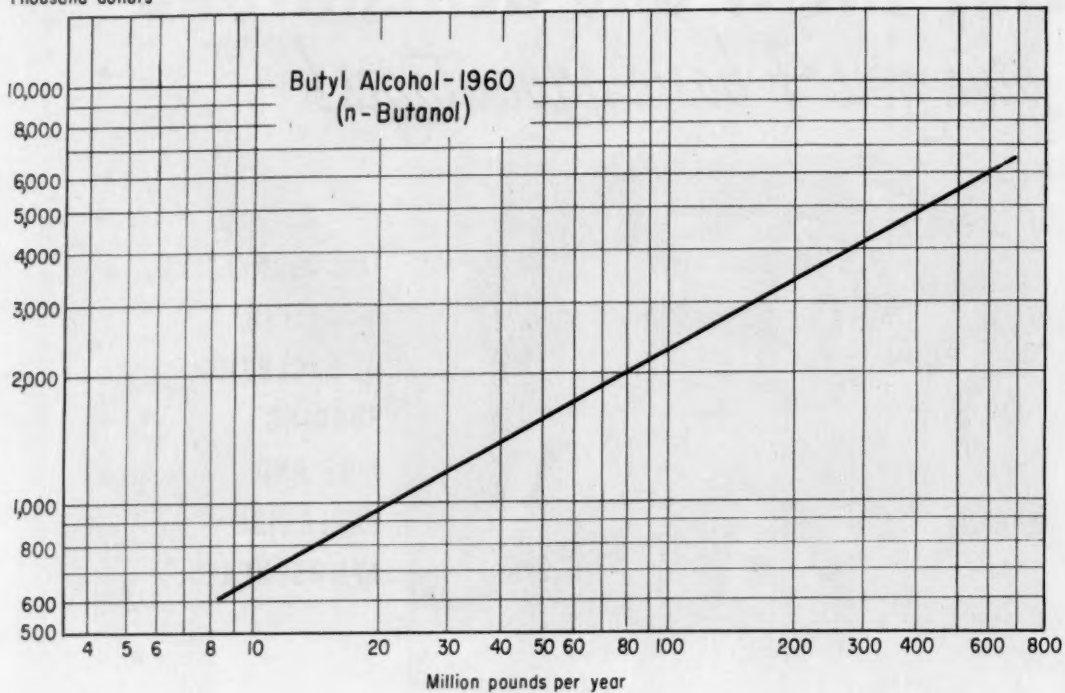
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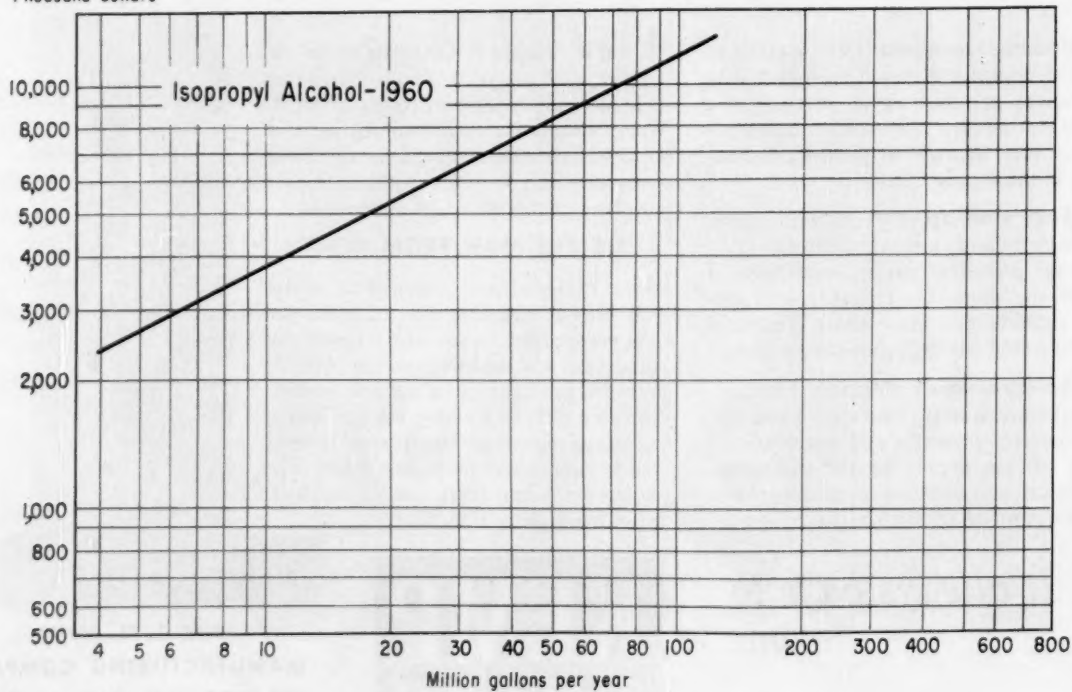
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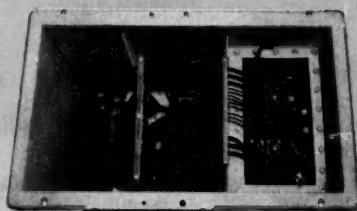
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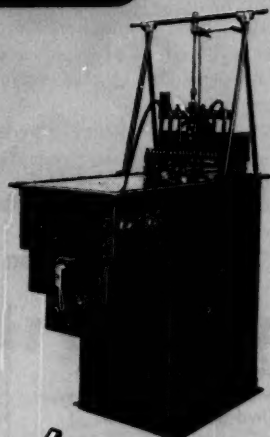
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# Corrosion-Resistant Hose:

## Where Does Teflon Fit In?

While not the answer to all problems, Teflon-lined flexible hose fills the gap between rubber and metal hose, providing flexibility and excellent corrosion resistance.

E. M. RAMBERG,  
Titeflex, Inc.

Until fairly recently, when some flexible hose had to be engineered into a process design, choice was limited to two materials: rubber or metal hose. Now, another material has joined this group. This is Teflon-lined flexible hose. Certainly no cure-all, Teflon-lined hose can solve many unusual and difficult fluid-handling problems.

To understand where hose fits into chemical plants, let's look at some typical applications:

- **Relative motion.** Hose is often the simplest, most practical solution when one component must move or be flexible. It avoids awkward and expensive elbows, fittings or rotary joints.

- **Vibration isolation.** Flexible hose can be effective in preventing

transmission of harmful vibrations from a motor or engine to other parts of a machine or other piece of equipment.

- **Correction for misalignment.** A short flex hose section can often be used in a plumbing circuit to correct for misalignment of components.

- **Absorbing expansion.** In systems subjected to significant temperature changes, there can be dimensional changes in piping, as well as major components, because of thermal expansion. This can overstress parts of the system if rigid plumbing is used throughout. Flex hose is often the most effective protection against such changes.

- **Installation requirements.** In many cases, flexible hose is used to avoid complex bends in tubing or special elbow configurations. It will also provide design flexibility so minor changes in equipment shape

or location will not make tubing or piping obsolete.

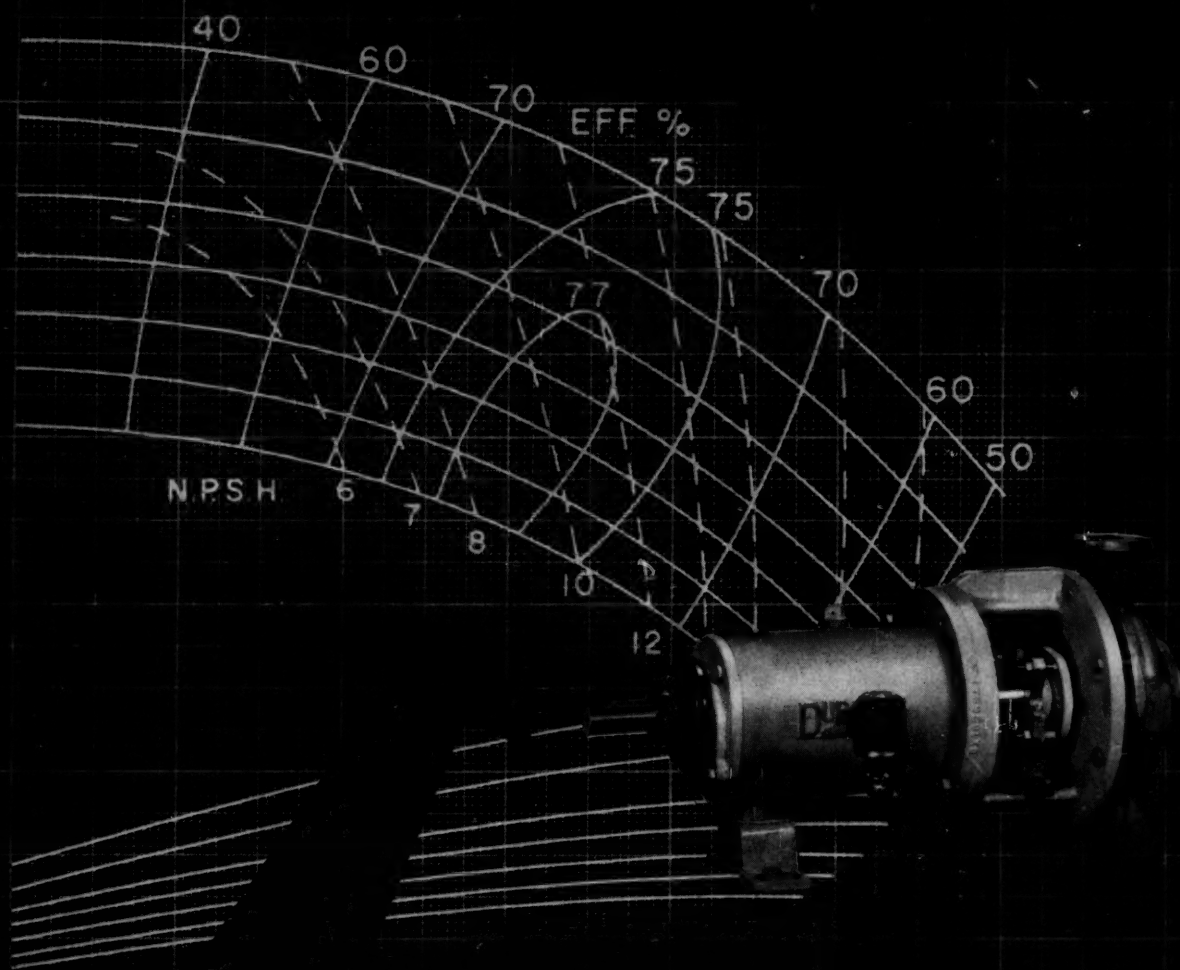
Rubber and metal hose have been adequately described in the literature. Since little has appeared on the newest member of this group, we will discuss it in some detail.

► **Plastic Inner Core—Teflon hose,** as produced for the large majority of fluid-carrying applications in the chemical industry consists of a thin inner core of Teflon, reinforced with metal-wire braid, and terminated with suitable metallic fittings.

For chemical industry applications, this combination offers many advantages. One, of course, stems from the exceptional inertness of Teflon, a material unaffected by most industrial chemicals including solvents, fuels, oils and chemical additives. About the only fluids that will attack it are fluorine or chlorine gas, at elevated tempera-

Teflon competes with rubber and metal—Table I

	Teflon	Rubber	Metal
High-temperature service	450F. max.	275F. max.	1,000F. max. (S.S.)
Low-temperature service	To -65F.	To -65F.	To -300F.
Maximum operating pressure (hydraulic hose)	1,500 psi. medium pressure 3,000 psi. high pressure	3,000 psi.	To 3,000 psi.
Capability with fluids	Inert to all fluids except fluorine & chlorine at elevated temperature & pressure	May require special compounds	Resistant to most fuels & corrosive fluids
Flexibility 1/2-in. dia. (min. bend rad.), in. 1-in. dia.	4 5/8 (extruded) 3 1/2 (convoluted)	5 to 6 9 to 10	7 to 9 11 to 12
Age, weather resistance	Excellent—unlimited shelf life	Poor to fair	Excellent
Normal size limitation	3/16-in. to 1 1/2-in. dia. (extruded) 3/4-in. to 2-in. dia. (convoluted)	To 2-in. dia. or more	To 6-in. dia.
Typical weight/ft. 1/2-in. dia. 1-in. dia.	0.3 lb. (extruded) 0.4 lb. (convoluted)	0.5 lb. 1.2 lb.	0.5 lb. to 0.6 lb. 0.9 lb. to 1.2 lb.
Approx. price/ft. 1/2-in. dia. 1-in. dia.	\$7 to \$9 (extruded) \$30 to \$40 (convoluted)	\$3 to \$4 \$5 to \$6	\$8 to \$9 \$17 to \$25



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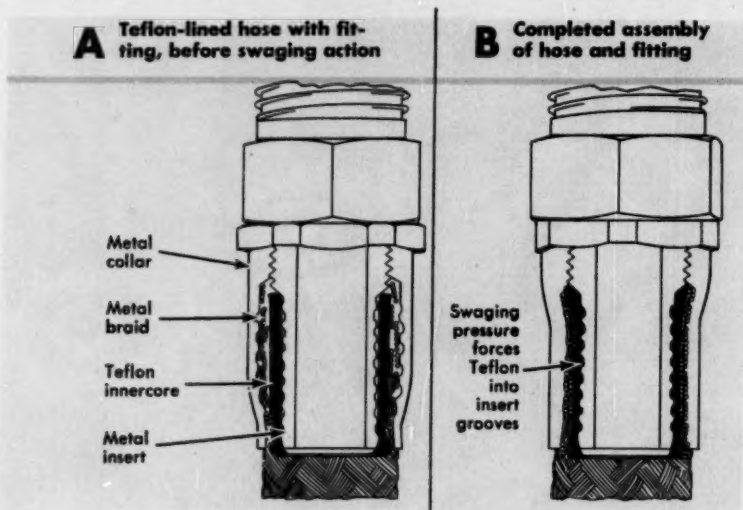
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## How to attach permanent fittings to lined hose—Fig. 1



tures, and molten metals such as liquid sodium.

Thus, Teflon hose offers a means of conveying fluids that would otherwise be difficult to handle. However, there are some limitations. Metallic end fittings must be either compatible with the corrosive fluid or they must be protected from attack. Also, effects of corrosives on the metal-wire braid should be considered in selecting a hose for a given application.

► **How It's Made**—In most instances, the Teflon inner core in hose lines is about 0.040 to 0.050-in. thick. This inner core is produced in a paste-extrusion process. Powder is carefully mixed with a lubricant and made into a preform, which then feeds into an extruder. As it leaves the extruder, the core is relatively fragile. It requires a sintering operation to produce the tough, homogenous structure characteristic of finished hose. Sintering involves heating the core to a temperature of about 620 F. for a few minutes, temperature and time being carefully controlled to precise limits.

Dust or dirt inclusions mean weak spots in the hose. And properties of the inner core will be affected by temperature and humidity changes in the compounding and extrusion area. Thus, reliable

suppliers of Teflon core have found it necessary to enclose their equipment in a temperature and humidity-controlled area. In addition, some hose suppliers find process control so important to product quality and reliability that they extrude their own inner core to meet the specific requirements of high-pressure-fluid systems.

► **Braid for Strength**—Finished core, after complete inspection for specific gravity, tensile strength, degree of sintering, cleanliness and pressure integrity, is ready for the braiding operation. Unlike some other types of hose construction, the inner core and wire braid of Teflon hose must be carefully matched to operate satisfactorily. The core serves as an elastic liner that is flexible, tough and durable. However, without braid, it can only withstand a pressure of about 100 psi. At lower pressures, even though it may not rupture, the core will expand radially and/or longitudinally. Thus, in a properly designed hose, the core transfers all working forces and stresses to the wire braid.

Effectiveness of a given braid pattern and design can be measured by the dimensional stability of the hose assembly when subjected to fluid pressure. The greater the change in length with

pressure, the less effective the braid in restraining the lining. Excessive changes are also objectionable since they reflect a scissor-type of action of individual braid wires, abrading the wires, which can lead to premature failure.

The combination of a properly designed Teflon inner lining and wire braid results in a hose structure that can withstand severe flexing as well as high fluid temperature and pressure and relatively high fluid impulses.

► **Leakproof Fittings**—The merits of this hose construction are to little avail, however, unless end fittings are similarly reliable and leakproof. The design of end fittings plus the method of attaching them are critical for a number of reasons. First, the core is thinner than rubber and other nonmetallic hose materials of comparable pressure rating. Second, the lining and braid are independent structures; the fitting must be designed to effect a fluid seal with the core, but must transfer all working stresses to the braid. Third, Teflon has a tendency to cold-flow when subjected to temperature and pressure and has thermal expansion characteristics considerably different than those of metals used for end fittings.

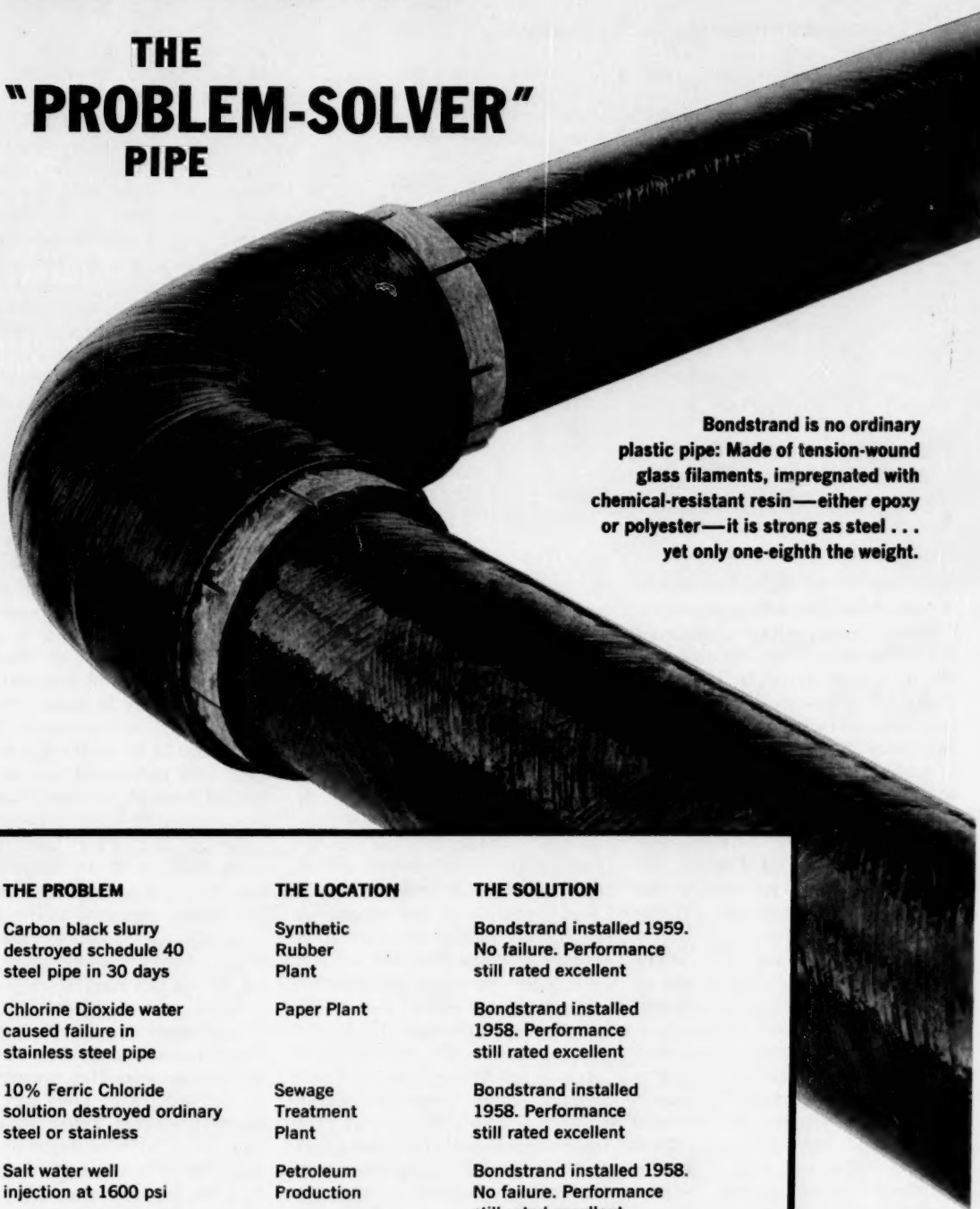
Because of these aspects of fitting design and attachment, hose suppliers have devoted considerable effort to development and evaluation of different fittings.

At the present time, there are two general classifications of fittings available for Teflon hose. One of these, called reusable or detachable, is designed to be assembled with hand tools. It has the advantage of allowing a user or distributor to make his own assemblies. He can stock bulk hose and fittings in economical and convenient form, cutting hose to length and attaching end fittings as he needs them. This practice is encouraged because Teflon hose, unlike rubber, is not affected by age or weathering and has almost unlimited shelf life.

Principal drawback of detachable end fittings centers around reliability. In addition to any

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Typical characteristics of Teflon hose—Table II

Nominal Size, In.	Diameter, In.		Min. Bend Radius, "In.	Pressure, Psi.		
	In- side	Out- side		Min. Burst	Recommended Operating, "Max.	Min. Test
Medium Pressure—						
3/16	0.128	0.259	2	12,000		
1/4	0.183	0.325	2	12,000		
5/16	0.245	0.405	3	10,000	1,500	3,000
3/8	0.307	0.469	4	9,000		
1/2	0.400	0.580	4 5/8	8,000		
5/8	0.495	0.687	5 1/2	7,000		
3/4	0.620	0.810	6 1/2	6,000	1,000	2,000
1	0.860	1.125	7 3/8	5,000	1,250	2,500
1 1/4	1.125	1.391	11	4,000	1,000	2,000
Convuluted—						
3/4	0.784	1.067	2 1/2	2,000	500	1,000
1	0.992	1.262	3 1/2	2,000	500	1,000
1 1/4	1.290	1.555	4	1,400	350	700
1 1/2	1.522	1.790	5	1,000	250	500
2	1.987	2.315	6 3/4	1,000	250	500

sensitivity of an individual design to manufacturing tolerances and a tendency to concentrate stresses in a localized area, they are susceptible to human error in assembly. Because of these reliability shortcomings, one of the military forces has recently prohibited use of detachable-type fittings on any of its equipment for airborne applications. However, where temperatures and pressures are well below maximum recommended values, and where reliability is not critical, the convenience of detachable fittings can often justify their use.

► **Permanent Fitting**—The other fitting available for Teflon hose is currently described as a swaged, permanently attached fitting. Several different variations of this design are available but, as a general rule, they all retain the plastic inner core between an external metal collar and an internal metal insert. Variations occur primarily in the method of retaining the core between these two elements.

One method (Fig. 1) accurately controls the direction and magnitude of forces applied to the core while the fitting is being attached. View "A" shows a fitting and hose before swaging. The innercore and braid are loosely retained in the fitting cavity. Swaging action starts at the lower end of the fit-

ting and immediately locks a predetermined volume of Teflon within the cavity. Then, as swaging is continued progressively along the fitting collar, the amount and direction of squeeze is accurately controlled within prescribed limits.

View "B" shows the cross section of a completed assembly. Teflon has flowed into grooves in the insert to produce a permanent fluid seal and similar grooves on the inside of the collar provide a positive lock of collar and wire braid. Careful control of the squeeze on the Teflon makes it possible to produce a fitting that will not leak even after hours of temperature cycling between -65 F. and 450 F.

► **Portable Equipment**—Until recently, one of the drawbacks of swaged-type fittings was that they required large, expensive assembling equipment. It was not practical to make assemblies in the field, and even hose distributors ordered factory-made assemblies. In recent months, however, new field-swaging tools have been marketed and it is now possible for a distributor or user to make his own assemblies from bulk hose and fittings. There are motor-driven versions available for large volume production, as well as hand-pump designs. Moreover, the draw-swaging dies can also be used in a standard hydraulic press,

so a user who has a press available need order only dies and related accessories to be able to assemble his own hose lines.

► **Types of Hose**—At the present time, Teflon hose is available in several designs to meet the needs of different chemical and other industrial applications. Differences between these products can involve the core, braid material and/or end fittings. For most chemical applications, an extruded inner core reinforced with one layer of stainless-steel wire braid and equipped with stainless-steel end fittings is recommended. Design characteristics of such assemblies are summarized in Table I.

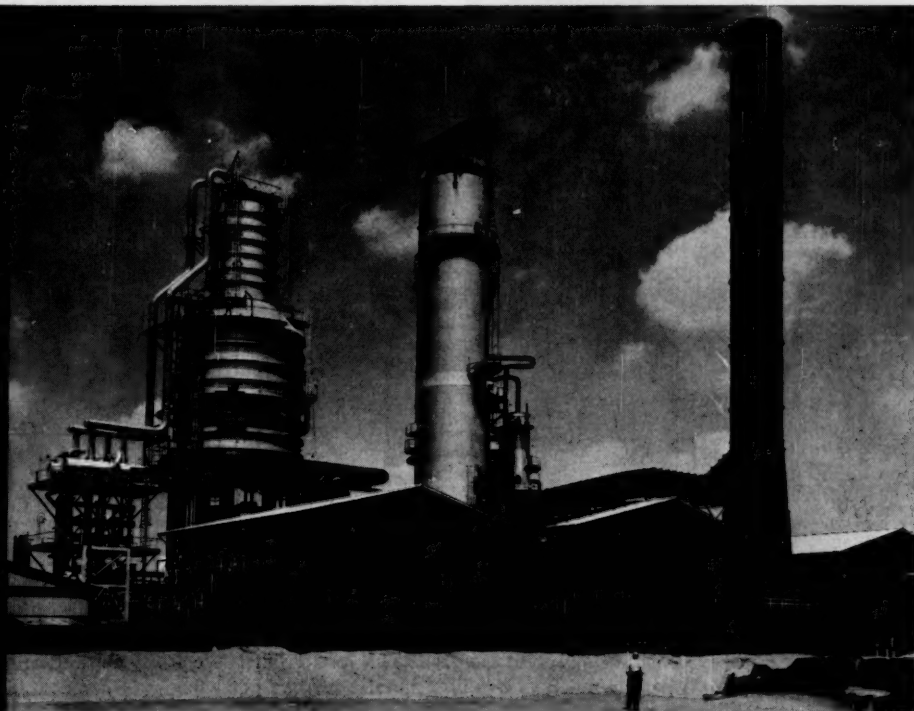
The size range of commercially available hose of this type is from 1/8-in. to 2-in. dia. Above 1 in., however, extruded Teflon is no longer truly flexible. Thus, to meet requirements for higher flexibility in large sizes, a different inner core has been developed. This is a thin Teflon liner backed with fiberglass that has then been convoluted to retain flexibility in large sizes. By comparison, an extruded Teflon inner core 1 1/4 in. in dia. has a minimum bend radius of 11 in., but convoluted hose of the same diameter has a minimum bend radius of 4 in.

Design and other performance characteristics of convoluted Teflon hose are summarized in Table II. As noted, sizes now available are 3/4 in. through 2 in. In the near future, however, sizes up to 4 in. will be on the market.

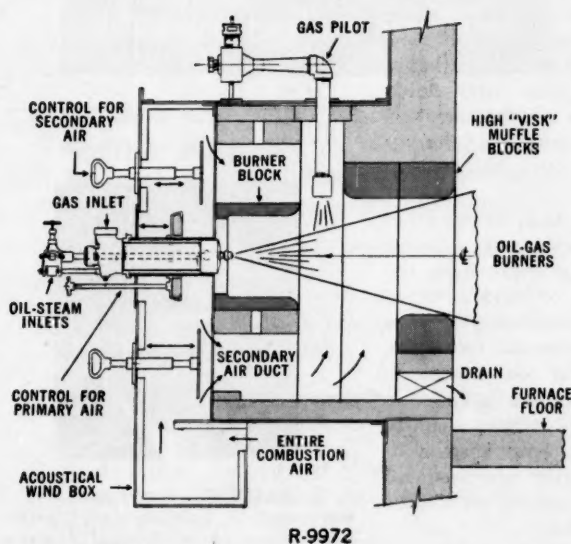
Teflon hoses described in Table II are generally classified as medium-pressure assemblies. They are suitable for operating pressures up to or less than 1,500 psi. For higher pressures, Teflon hoses with two layers of wire braid are now available. These are rated at 3,000 to 4,000 psi. However, in applying them to chemical applications, it should be noted that some assemblies have carbon-steel wire for the first layer of braid. This may not have adequate corrosive resistance. Available sizes are 1/2 through 3/4 in.

Most of the assemblies described are available with flange, elbow or other fitting terminations to meet specific industrial requirements.

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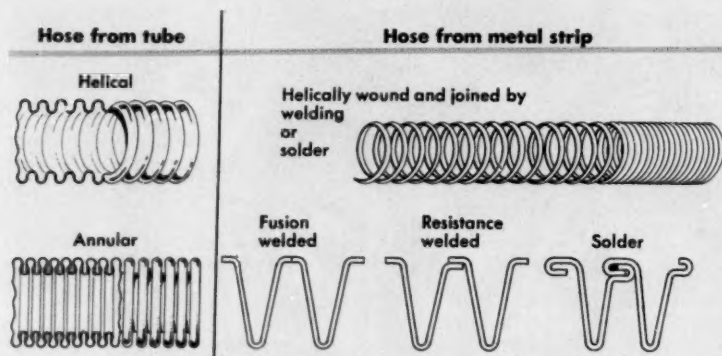
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## Tubing, strip go into metal-hose construction—Fig. 2



For chemical application, these fittings are usually produced in a 300-series stainless steel. In addition, one manufacturer is now offering end fittings coated with Kel-F. Intended primarily for applications wherever Type 316 stainless steel does not provide adequate corrosion protection, these assemblies offer a completely inert plastic surface on all members exposed to a corrosive fluid. For other applications, end fittings are available in brass, aluminum, and carbon steel. In most instances, the latter are usually protected with a corrosion-resistant coating.

Wire braid used on most Teflon hose assemblies is a 300-series stainless steel. However, other combinations are available such as brass end fittings and bronze-wire braid.

► **Metal Hose**—This is not to say that Teflon hose is the answer to all problems. Flexible metal hose, of course, is widely used in chemical plants. As Table I shows, nothing can approach it when it comes to high- or low-temperature resistance. The hose is available in a variety of metals, with stainless and copper alloys popular for corrosive service.

Convolutions of metal hose may be helical or annular (Fig. 2). Mechanical performance is about the same for both types of construction.

Metal hose inner core is produced from metal strip, or welded or seamless tube. The metal core is

easier to elongate than a plastic inner core but the metal is relatively rigid radially. Braiding is used to absorb load from the core. Usually, metal hose has good flexibility to about 1½-in.

Fittings are not a particular problem with metal hose. Soldering, brazing, welding are all used for attaching fittings.

► **Rubber Hose**—Standard rubber hose, a low-cost item, consists of an inner tube, a carcass of fabric or cord, and a cover. The tube can be made from a wide variety of rubbers—either natural or synthetic. When the hose must carry fluids under pressure, a reinforcement of cotton, rayon, nylon, steel, or combinations, is wound or braided around the tube.

Rubber hose is made by two processes: long length and mandrel built. In the long-length hose, the carcass consists of yarn or cord braided continuously over the tube with the cover extruded on. Tube, carcass and cover are heated to cure the rubber and produce a strong bond. This technique can be used to produce long lengths of hose. Short lengths are produced by wrapping the carcass around the rubber on a mandrel.

In carrying corrosive or abrasive materials, it is often necessary to couple rubber hose without permitting the materials to contact metal. An all-rubber flange has been developed for this. Rubber flanges are made integral with the hose. Flanges are held together with

bolts acting on metal rings outside the flanges.

► **How Costs Compare**—Although generally more expensive than rubber hose, extruded Teflon hose now compares favorably in initial cost with flexible metal hose that is suitable for chemical or corrosive-fluid applications. Taking into account the almost unlimited shelf life, the excellent flex life and durability of this hose, over-all cost is usually in Teflon's favor.

When stainless-steel end fittings are required, these often represent 50 to 75% of the total cost of the assembly. This has been another desirable feature of detachable types of end fittings. However, it is now possible to get an adapter for the field-swaging tool, which makes it possible to re-use all fitting components except collars, thus considerably reducing costs.

With convoluted Teflon hose, cost will be higher than metal or rubber hose of the same diameter. This is largely due to manufacturing costs but undoubtedly also reflects current low-production requirements. As demand and production volume are increased, present price differences should decrease.

### Meet the Author



E. M. RAMBERG is vice president of marketing at Titeflex, Inc., Springfield, Mass. A mechanical engineer from Lehigh Univ., he worked for Sperry Gyroscope on the Sparrow missile before joining Titeflex, and was formerly director of engineering, then vice president of engineering at Titeflex, before moving into his present position.



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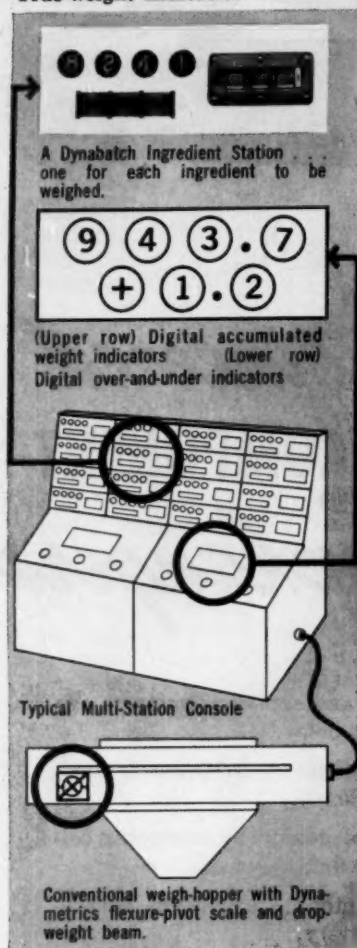
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**DYNAMETRICS  
CORPORATION**

Northwest Industrial Park,  
Burlington, Massachusetts • BRowning 2-1600

MORE CPI NEWS BRIEFS . . .  
(continued from page 10)

tory at Ft. Kearney. It will be designed for a power level of 3,000 thermal kw., will be used for state-sponsored research as well as for programs conducted by the University of Rhode Island, Brown University and Providence College. Design and construction of the reactor will be by General Electric Co.'s Atomic Power Equipment Dept., San Jose, Calif.

**Air Products, Inc.**, Allentown, Pa., is building a large manufacturing and distributing plant just south of Minneapolis, which will supply industrial and medical gases to consumers in the Minneapolis-St. Paul area. It will also distribute a complete line of welding and cutting equipment.

**Rexall Chemical Co.** plans construction of a new polystyrene plant, to be in production by mid-1961, as part of an expansion program in the petrochemicals field. Initial capacity will be 25 million lb., and the facility will be built at an undisclosed Midwest location. It will complement polystyrene plants that Rexall currently operates in Massachusetts and California.

Also in the offing is a Rexall plan to enter the polyethylene resin market under resale arrangements with undisclosed suppliers, until petrochemical facilities that the firm is building jointly with El Paso Natural Gas Co. at Odessa, Tex., come on stream, tentatively in early 1962 (*Chem. Eng.*, June 27, 1960, p. 152).

**Northern Gas Products Co.** anticipates an August 1961 completion for a new \$10-million extraction plant plus other facilities at Bush-ton, Kan. Company will use a low-temperature process in separating propane and heavier hydrocarbons from 896 million scfd. natural gas. Engineering and construction are being handled by The Fluor Corp., Ltd.

**Allied Chemical Corp.** has announced that its Nitrogen Div. will install facilities at an undisclosed

location to produce melamine crystals. Capacity will be around 20 million lb./yr., and output will go both to Allied's Plastics Div. and to outside consumers. Plant will employ urea as raw material, will use a process developed by the Nitrogen Div.'s research organization. Completion is scheduled for early '62.

**General Electric Co.** plans to establish an Advanced Computer Development and Research Laboratory at Sunnyvale, Calif., near San Francisco. The 49,000-sq. ft. facility will cost about \$1.5 million. It will initially be staffed by about 150 administrative and professional personnel, and GE plans to expand this figure to about 400 by '70.

The laboratory staff will conduct research in advanced computer techniques for industrial and commercial applications, will also carry out applied computer engineering in areas such as circuits, computer devices, advanced logic and information theory studies.

Construction is scheduled to get under way this spring, and General Electric expects the facility to be ready for occupancy by December.

**Metal Carbides, Inc.**, Youngstown, Ohio, is building a plant at Murfreesboro, Tenn., for manufacture of tungsten carbide. It will contain 6,000 sq. ft., will employ 15 to 25 people. Company hopes to have the new facility on stream by next fall.

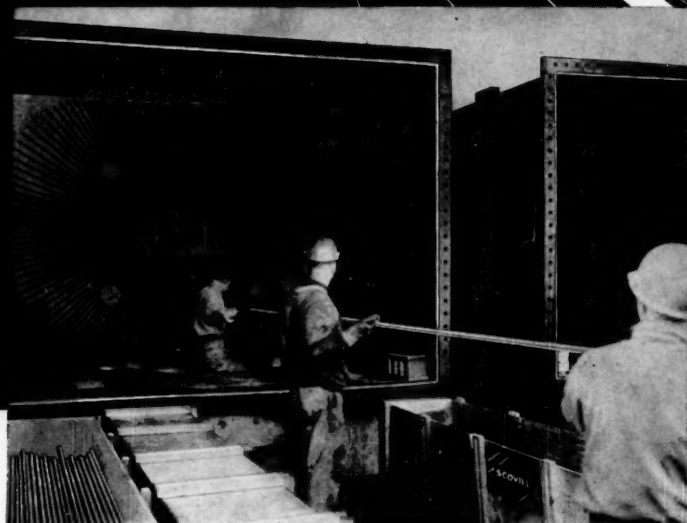
**Platronics, Div. of Palumbo Bros., Inc.**, Linden, N. J., recently held open house at a new electroplating plant in that city, said to be the country's largest plant for electroplating of electrical and electronic components with precious or base metals.

**Johns-Manville** will expand capacity of its Waterville, Ohio, plant to make textile fiber glass by 40%. Half the increase will come as a result of new equipment, and the rest will be due to improved efficiency of the plant's current facilities.

(continued on page 195)

# YANKEE ATOMIC

trouble-free performance



installing more  
than 70 miles of

HIGH RELIABILITY . . . trouble-free performance . . . has become a very specific goal of engineers in the Atomic Age.

This applies whether the problem is reliability of controls in a space vehicle or reliability of the operating equipment in New England's first Atomic Power Plant at Rowe, Massachusetts, being designed by Stone & Webster Engineering Corporation in collaboration with Westinghouse and constructed by Stone & Webster.

Scovill salutes the Yankee Atomic Electric Company's project, where 11 future-minded New England Utilities have set a new milestone in a field of unlimited promise.

Scovill's contribution is HEAT EXCHANGER TUBING . . . mile upon mile of precision-built tube that shoulders a major responsibility for the trouble-free operation of this installation.

Here are shown being installed some of the more than 12,000, 30-ft. long Scovill Inhibited Admiralty Tubes (7/8" OD X .049" wall) specially made to extremely tight specifications for the main condenser in the Yankee Atomic Electric Company plant . . . over 70 miles of tube, every foot of which has passed the most rigid inspection.

Here, as elsewhere, Scovill Heat Exchanger Tube alloys and Scovill Technical Services have been recognized as among the finest available . . . to assure trouble-free performance.



INHIBITED ADMIRALTY

## heat exchanger TUBE

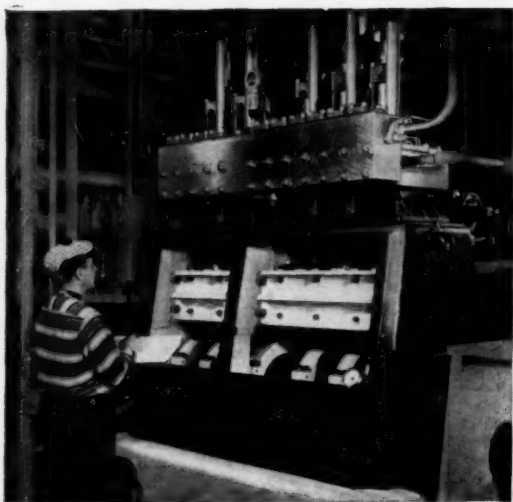
**HEAT EXCHANGER TUBE** for Applications from Marine to Petrochemical, from Compressor Intercoolers to "Cat-Cracker" Exchangers, in these popular Alloys . . .  
Phosphorized Admiralty • Admiralty • Arsenical Admiralty  
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• Aluminum Bronze, 5% • Muntz Metal • Duplex Tube

**SCOVILL MANUFACTURING COMPANY**

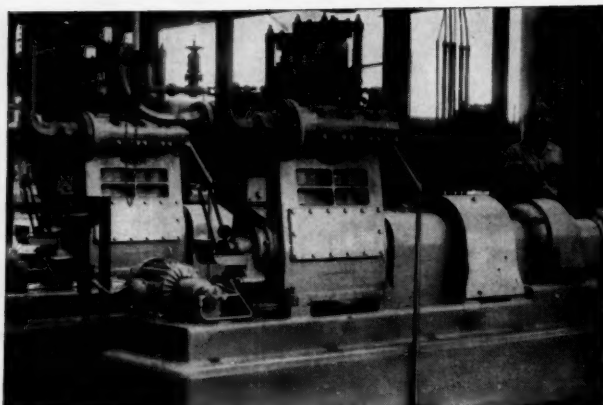
Mill Products Division, 99 Mill Street, Waterbury, Connecticut. Phone PLaza 4-1171.



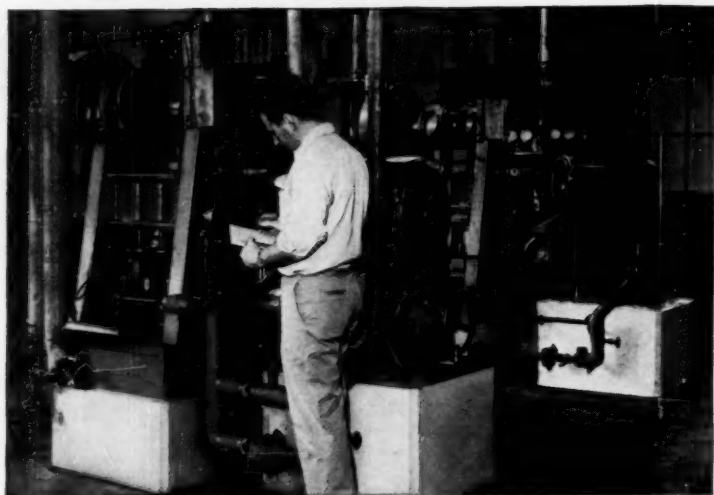
1SC60



1



2



3



4

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*which type of flow is giving you pump trouble?*

If your pressures are high...

If a corrosive, abrasive, viscous or highly compressible liquid is giving your pumps a hard time... Aldrich can answer your problem! We *specialize* in pumps for hard-to-handle liquids in the chemical industry... working with the widest range of special fluid-end materials and designs in the industry today.

For example: in installation #1 above, an Aldrich pump with stainless steel fluid-

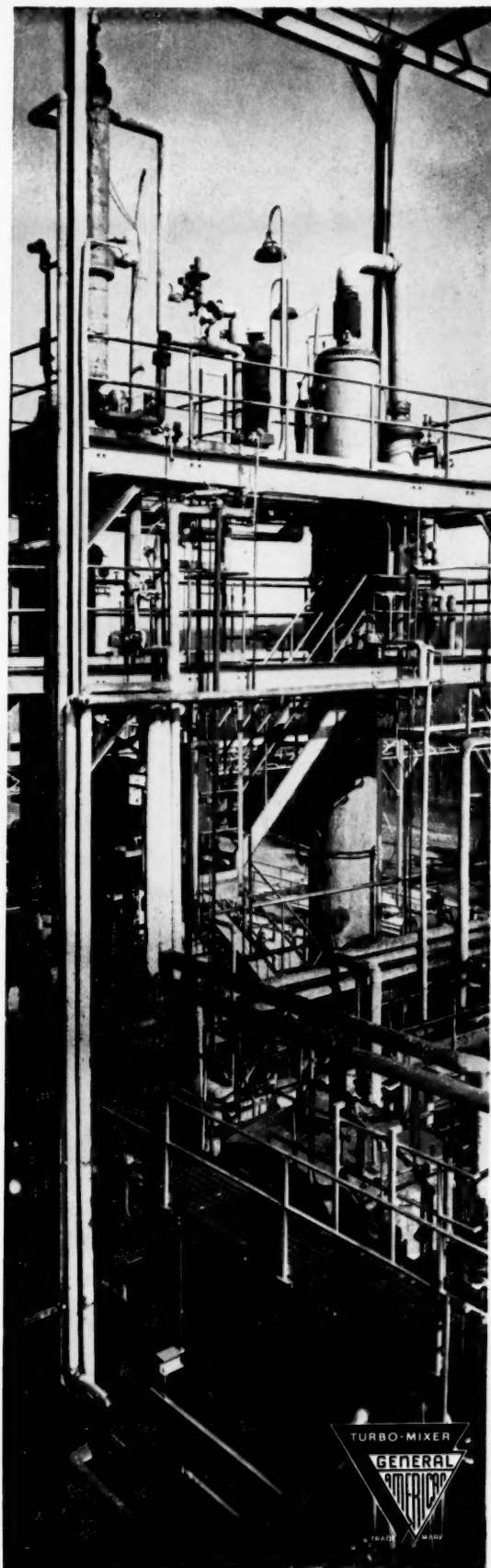
ends and special nylon ball valves eliminated severe maintenance problems in handling silica gel at 1800 psi. In installation #2, fluid-ends of 3½% nickel steel have been handling a 50% caustic soda solution continuously for over two years. The reliability record has been perfect. In installation #3, a special Aldrich pump with stainless steel fluid-end has given 8 years of uninterrupted service handling a hot resin ester at

6000 psi. In installation #4, Aldrich pumps with stainless steel fluid-ends have served continuously for over 12 years, pumping hot, corrosive, fatty acids.

Aldrich Pumps range from 25 to 2500 hp.; pressures to 50,000 psi. For additional information, see our insert in *Chemical Engineering Catalog*. For complete data, or help on a specific problem, write Aldrich Pump Company, 3 Gordon Street, Allentown, Penna.

THE TOUGH PUMPING PROBLEMS GO TO





# TRY THIS SIMPLE QUIZ ABOUT THE **RDC** COLUMN

## 1. *R.D.C. stands for*

- ☐ a) Rapid Dispersion Column
- ☐ b) Recycle Displacement Column
- ☐ c) Rotating Disc Contactor

## 2. *RDC Columns are made by*

- ☐ a) 6 different manufacturers
- ☐ b) by one manufacturer
- ☐ c) by 10 manufacturers

## 3. *The RDC column has been used for*

- ☐ a) Separation of Hafnium from Zirconium
- ☐ b) Caustic extraction of acids from organics
- ☐ c) Caffeine and vanillin extraction

## 4. *The RDC column can be used for*

- ☐ a) liquid-liquid extraction
- ☐ b) liquid-solid extraction
- ☐ c) liquid-slurry extraction

## 5. *The RDC column has which of these advantages*

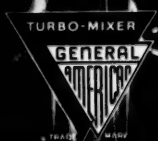
- ☐ a) High volumetric efficiency
- ☐ b) No interstage coalescing or external settling
- ☐ c) Low power requirements

### **Answers**

1. (C) Rotating Disc Contactor.
2. (B) RDC columns are made for the process industries exclusively by General American, and on a non-exclusive basis for the petroleum industry.
3. (A), (B) and (C). For a complete list of typical systems in service, contact General American.
4. (A), (B) and (C) again. The RDC column is one of the most versatile tools available for extraction processing.
5. (We did it again—all three are correct).

If you'd like more information on the RDC column and the many advantages it offers, send for Bulletin T-1159. You'll find it pays to plan with General American.

Process Equipment Division—Turbo-Mixers  
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## **M-S-A® DURA-GRIP STAYS DOWN, STAYS SAFE**

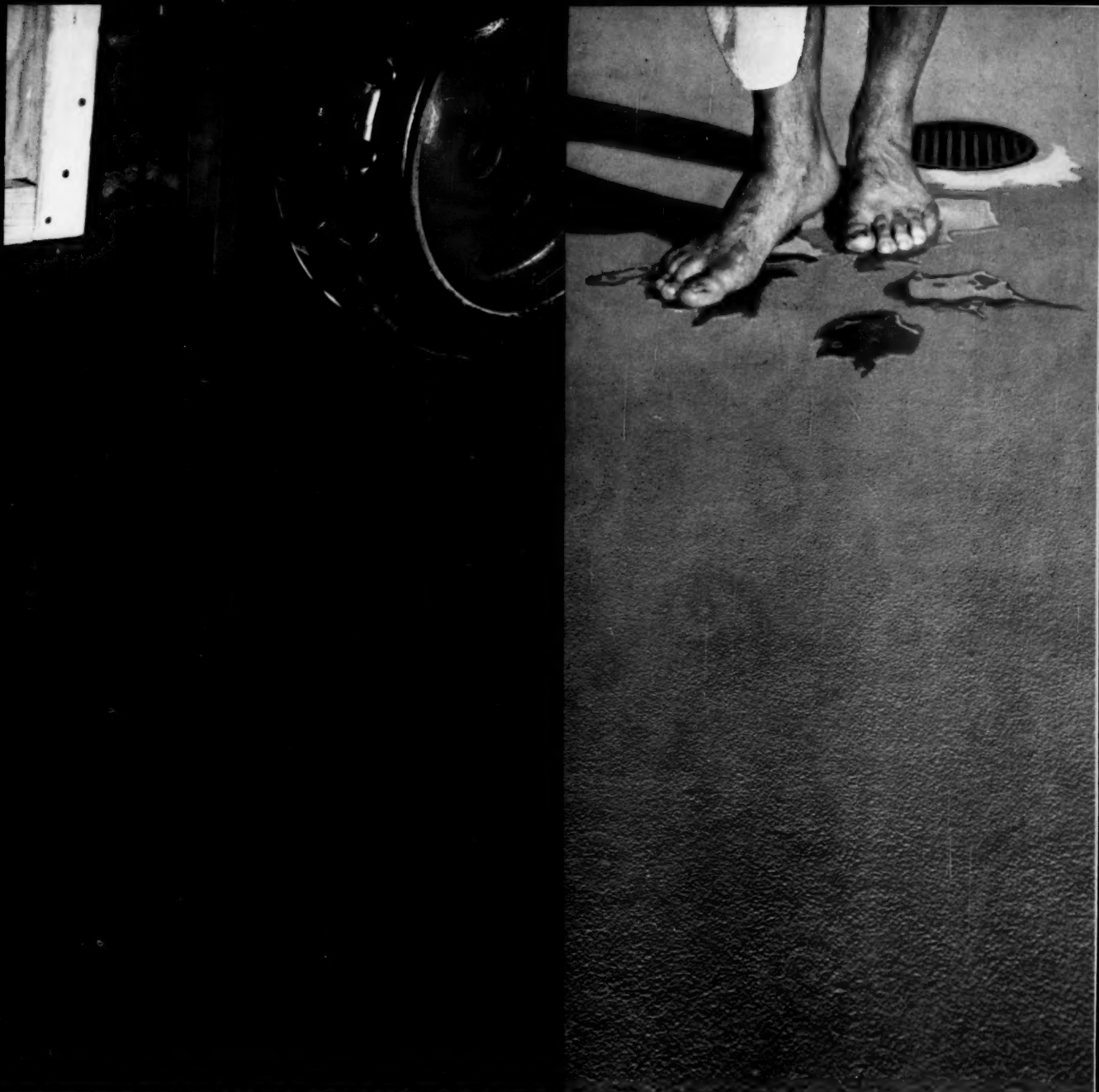
On properly prepared surfaces low-cost, non-skid, Dura-Grip will wear for years. This anti-slip surfacing compound will *not* come up. The tenacious bonding agent is a special polyurethane compound proved superior in actual customer exposure tests. Hard, protruding aluminum oxide grits put abrasive teeth in the rugged-duty locking coat.

In case after customer case "no premature resurfacing" was reported. No more on-again, off-again adhesive problems. Over 1,000 important companies have purchased M-S-A® Dura-Grip since its introduction in late 1959.

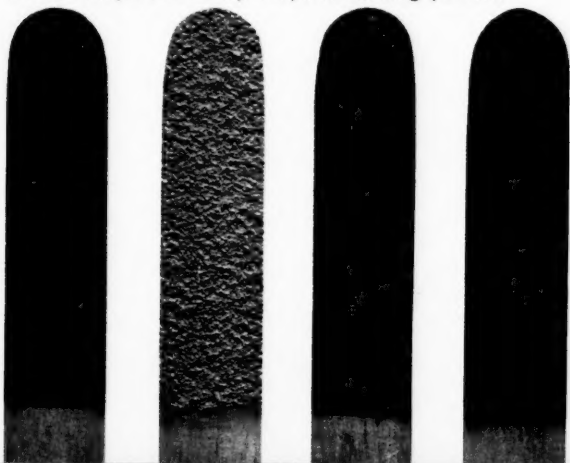
Use it on concrete. On metal, wood or marble. Inside or outside. Any place traffic could conceivably slip, slide, spin or fall.

Slip-proofs stairs, floors, ramps, catwalks, shower rooms, entrances and transportation equipment. Resists acids, alkalies, greases, oils, solvents. Gives a smooth, uniform surface.

Your choice of colors in black, gray, yellow or red. For price, delivery and application information, please write MSA on your company letterhead. And ask us for specially prepared samples shown at right.



**FREE SAMPLES!** Carry out your own torture test. Dip other end of free prepared sample into any other surfacing material of your choice. Compare Dura-Grip's superior bonding qualities.

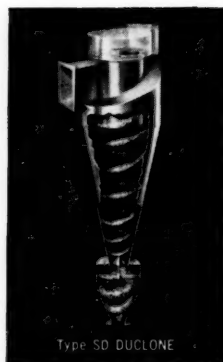


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Industrial dusts have split personalities. They can be peace loving, pleasant, and in some cases precious . . . in the proper environment. But let them get out into the open air where they are free to roam and settle where they please! They become unbearable public enemies . . . atmospheric delinquents. Take fine mineral particles, for instance. In their proper setting their brilliance and striking colors would stir the heart of a poet. But who would want them settling from the sky on a white suit or staining a newly painted house? Esthetic beauty in one place can be unwanted ugliness in another.

Let Ducon dust specialists psychoanalyze your industrial dust and prescribe the right treatment to keep it under control. We have a full line of wet and dry dust control devices to solve your problem.

Write for Bulletin C 1058



the name in DUST CONTROL  
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ties. As part of the program, 45,000 sq. ft. of new manufacturing, storage and shipping space will be installed. Company had announced earlier that it would install a glass batch furnace at Waterville also, but has since decided to locate the furnace at its Parkersburg, W. Va., plant instead.

**Monsanto Chemical Co.** is nearing completion of a 50% capacity increase for its vinyl chloride monomer plant at Texas City, Tex. Expanded capacity will be 150 million lb./yr. Currently, raw-material acetylene and ethylene are supplied by Texas City operations; next year, additional ethylene will be available from Monsanto's forthcoming petrochemical project at Chocolate Bayou, Tex. (*Chem. Eng.*, Jan. 23, 1961, p. 76).

**Wyandotte Chemicals Corp.**, Wyandotte, Mich., has opened a plant at Washington, N. J., to make polyether products. The facility employs about 20 persons and is the firm's first plant in the East.

**Humble Oil & Refining Co.** plans to expand paraxylene capacity from 65 million to 105 million lb./yr. at its refinery in Baytown, Tex. Expansion is scheduled for completion by April, 1962.

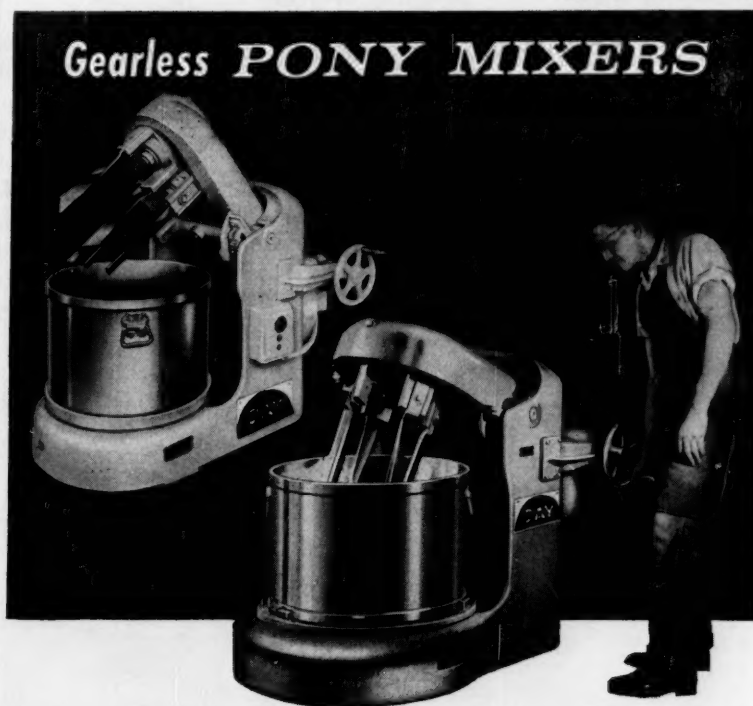
**Murphy Corp.**, El Dorado, Ark., plans a construction program for its oil refinery in Superior, Wis. Additions will include a 5,000-bbl./day fluid catalytic cracking unit, a 1,200-bbl./day hydrofluoric acid alkylation unit, a 400-bbl./day increase in capacity to desulfurize distillate fuels and an increase in gasoline treating capacity from 1,500 to 4,500 bbl./day.

The project will also include new tankage totaling 200,000 bbl. of capacity, a tetraethyl lead blending plant, a laboratory building and a new railroad siding.

Construction will begin as soon as engineering is completed and materials are procured, will require 9-11 months.

**Tennessee Corp.'s U. S. Phosphoric Products Div.** has announced a multimillion-dollar expansion pro-

## Check the **PROFIT** of **POINTS** **DAY**



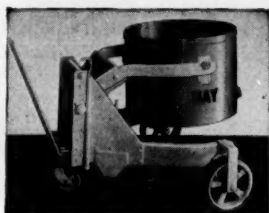
**1. FAST, UNIFORM BLENDING** of all ingredients being mixed. Agitator action insures against "dead spots" and stratification of materials—whether dry mixes, pastes or high viscosity liquids.

**2. RUGGED, RIGID, TROUBLE-FREE** construction makes DAY the standard of dependability. One piece cast frame assures absolute rigidity. Geared head motor drives agitators and can through roller chain and sprocket.

**3. GUARANTEED PRODUCT PROTECTION** from grease and oil. No bearings or stuffing boxes in the product zone.

**4. QUICK, EASY REMOVAL OF AGITATORS** from the batch. Counterbalanced head tilts easily by hand-wheel. Power tilting optional.

**5. A MODEL FOR EVERY NEED** with single motion or twin motion mixing action, one or two speed motors, in working capacities from 3 to 125 gals.



For full details, call in the Day field engineer in your area or write for Bulletin No. 500.

Mixer shown above, top, is Day Twin Motion Pony Mixer, having twin spindles with counter-rotating, overlapping blades. Shown immediately below is Day Single Motion Mixer. Day hydraulic lift trucks, left, and extra interchangeable cans, will further speed your production.

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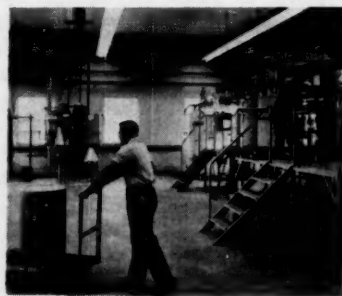
THE BELMONT PACKING & RUBBER COMPANY • PHILADELPHIA 37, PA.



### CPI NEWS BRIEFS . . .

gram for its operations at Gibsonton, Fla. This program will be in addition to an \$11-million ammonia plant currently under construction. The new facilities will increase output of phosphate products by 50%, and they are expected to be completed by late '61 or early '62.

Champlin Oil. Co. plans a \$3-million expansion for its refinery at Enid, Okla. Project will include a delayed-coker unit, capable of processing 4,000 bbl. oil and 150 tons petroleum coke per day.



Metal & Thermit Corp., Rahway, N. J., has opened a new, 13,000-sq. ft. laboratory in that city for high-temperature research dealing with inorganic chemistry, ceramics, metals and minerals. It will house projects involving temperatures of 350 F. and higher. Included is a ceramic materials processing room, a furnace and smelter room, a ceramic technical service center, a mill room and a pilot-plant area for work on inorganic chemicals; part of the latter is shown above. One feature of the laboratory is a circular tunnel kiln that was designed by M&T personnel.

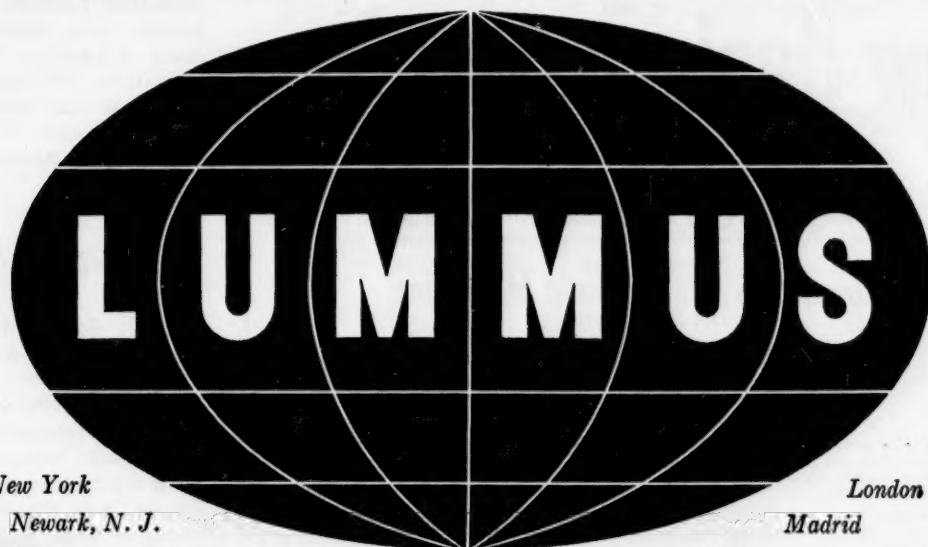
Monsanto Chemical Co. will build a major plant on a 3,000-acre site at Chocolate Bayou, near Houston, Tex., to supply hydrocarbon raw materials for the firm's manufacturing operations, particularly those at nearby Texas City. Feedstock and fuel for the new plant will come from oil and gas reserves held by Monsanto's Lion Oil Co. Div.

Over-all facility will include what is described as the world's largest ethylene plant, with ca-

IF YOU'RE PLANNING TO BUILD A NEW  
PLANT TO MAKE ANY OF THESE CHEMICALS...



TALK TO LUMMUS FIRST... LUMMUS'  
WORLD-WIDE ORGANIZATION HAS HANDLED THESE AND MANY MORE



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### CPI NEWS BRIEFS . . .

capacity of over 500 million lb./yr. Other production will include 42 million gal./yr. benzene, 50 million lb./yr. naphthalene, and undisclosed amounts of propylene, cumene, phenol, acetone, ethyl benzene and other hydrocarbons.

Bechtel Corp., San Francisco, will assist Monsanto in design and construction. Site preparation is now getting under way, construction will start early this summer, and the plant is scheduled for operation in '62.

### Companies

Kerr-McGee Oil Industries, Inc., Oklahoma City, Okla., has acquired full ownership of Kermac Nuclear Fuels Corp. Kermac operates a uranium processing plant—described as the country's largest—in New Mexico's Ambrosia Lakes area, and is said to hold some 20% of all known U.S. uranium reserves. At the same time, Kerr-McGee has acquired other mining properties in the West.

Monsanto Chemical Co.'s shareholders have approved the purchase of American Viscose Corp.'s interest in The Chemstrand Corp. Result of the purchase: Chemstrand becomes a wholly owned subsidiary of Monsanto.

### International

**France:** Societe de la Raffinerie de Strasbourg S. A. is a joint venture of Societe Francaise des Petroles BP (French associate of British Petroleum) and two other, undisclosed companies. It will build a petroleum refinery at Herrlisheim, near Strasbourg, with capacity of about 66,000 bbl./day, to supply marketing areas of north-east France, south Germany and Switzerland. Estimated cost: about \$61.6 million.

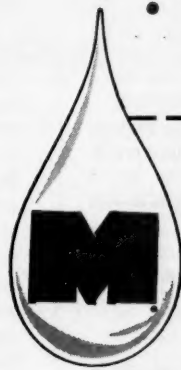
**Algeria:** British Petroleum's French affiliate will also participate

An announcement of special importance  
to users of phosphoric acid:

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new superconcentrated 105%  
phosphoric acid offers you  
these important advantages:

- versatile natural desiccant (only 24%  $H_2O$ ); works fine in reactions where less concentrated phosphoric, containing appreciable water, is unsuitable;
- excellent sequestrant for trace minerals;
- lively catalyst or dehydrator in organic synthesis;
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- less corrosive, easier to handle—dilutes readily, too;
- *immediately available*, PHOSPHOLEUM superconcentrate can shave \$\$\$ off your freight and storage expenses.



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Inorganic Chemicals Division  
St. Louis 66, Missouri

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# Chill-Vactor



## Comes Nearest to Natural Refrigeration

Nature produces refrigeration (snow, sleet, and hail) indirectly by change of atmospheric pressure to bring warm water vapor in contact with cold air.

XXCIV

XXB

In each case, water is its own refrigerant or cold air serves the purpose. Jet vacuum refrigeration comes nearest to this natural refrigeration.

NO CHEMICAL REFRIGERANT OR ABSORBENT TO LEAK, CORRODE OR CRYSTALLIZE

As a method of industrial refrigeration, jet vacuum refrigeration is thoroughly established and is successful in many hundreds of industrial plants in capacities varying from a few tons to 4500 tons.

The unit sketched can be placed outdoors and operated continuously or intermittently in any climate. The equipment adapts itself readily to automatic control or is very easy to control manually. The unit is self-supporting. There are no moving parts, no noise, no vibration. The maintenance and supervision required are negligible.

While most vacuum installations are used to cool water, vacuum cooling is particularly efficient for cooling chemical solutions. Instead of the usual expensive heat transfer surface required, only simple corrosion resistant vessels are needed.

Some process plants have dozens of separate units totaling thousands of tons of refrigeration just for the purpose of cooling chemical solutions.

There are many other applications, too. Fresh vegetables and other moist solids are readily cooled by jet vacuum refrigeration. By adding a heat exchanger bundle inside the vacuum chamber, gases can be cooled without circulating any liquid. In some cases, the automatic de-aerating effect of vacuum cooling is important.

Many installations of old style mechanical refrigeration could be replaced profitably with vacuum refrigeration, which costs much less to buy and somewhat less to operate.

All inquiries will be given careful engineering study without obligation.



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### CPI NEWS BRIEFS . . .

in a 50,000-bbl./day refinery that is to be built at Maison Carrée, near Algiers. Eight companies are joining in this venture, and cost of the refinery will be about \$47.6 million. It will comprise an atmospheric distillation unit and a catalytic reformer, and its output will be sold on the domestic market.

**Egypt:** The United Arab Republic's Five Year Plan Authority has announced it will start constructing a superphosphate fertilizer plant at Nag Hamadi this year. Plant will be owned by farm co-operatives in the area, will have initial capacity of 40,000 tons/yr.

**Venezuela:** Reynolds International, Inc., subsidiary of Reynolds Metals Co., Richmond, Va., has concluded an agreement with the Venezuelan government to form a corporation that will build an aluminum reduction plant in the southeastern part of the country. Ultimate cost of the facility is expected to be over \$30 million, and production capacity at startup will be about 25,000 tons/yr. Ownership of the plant will be 50% by Reynolds International and 50% by a Venezuelan company representing government interests.

**Canada:** Sun Oil Co., Ltd., is erecting a \$700,000 hydrodesulfurizer unit to treat heating oils at its refinery in Sarnia, Ont. It will have capacity of 2,600 bbl./day, will use a special, undisclosed catalyst. It is scheduled to be in operation by mid-May.

**Japan:** Nippon Dextrose Co. is a new firm that has been formed jointly by Japan's Ajinomoto Co. and Toyo Sekikan, and Corn Products Co., New York, to produce dextrose from sweet potatoes. It will build a 13,000-ton/yr. facility at Yatsushiro, Kyushu. This project will provide Japan with a means for disposing of excess sweet-potato production, while at the same time lowering sugar imports.

**Argentina:** Cabot Argentina S.A.I.C., subsidiary of Cabot Corp., Boston, is erecting a 30-million-

# acids

If you use any of these chemicals, PYREX® Pipe solves your corrosion problems completely

ACETALDEHYDE ACETIC ACID (ALL CONC.) ACETIC ANHYDRIDE ACETONE ACETYL CHLORIDE ADIPIC ACID ALUM AMMONIUM CHLORIDE AMMONIUM NITRATE AMYL CHLORIDE ANILINE AQUA REGIA ARSENIC ACID BARIUM CHLORIDE BENZALDEHYDE BENZENE BENZOIC ACID BORAX BORIC ACID BROMIC ACID BROMINE, LIQUID BROMINE WATER BUTANOL BUTYL ACETATE BUTYRIC ACID CALCIUM HYPOCHLORITE CALCIUM NITRATE CARBONIC ACID CARBON DISULFIDE CARBON TETRACHLORIDE CHLORACETIC ACID CHLORINE GAS, WET, DRY CHLORINE WATER CHLOROBENZENE CHLOROFORM CHLOROSULFONIC ACID CHROMIC ACID CITRIC ACID CRESOL CUPRIC SULFATE CYCLOHEXANOL DIMETHYLAMINE ETHYL ACETATE ETHYL ALCOHOL ETHYL CHLORIDE ETHYL ETHER ETHYLENE BROMIDE FERRIC CHLORIDE (SAT.) FERROUS SULFATE FORMALDEHYDE FURFURAL HYDROBROMIC ACID HYDROCHLORIC ACID HYDROGEN PEROXIDE HYDROGEN SULFIDE IODINE KEROSENE LAURYL CHLORIDE LEAD ACETATE MAGNESIUM CHLORIDE MAGNESIUM HYDROXIDE MALIC ACID MERCURIC CHLORIDE MERCURY METHYL ALCOHOL METHYL CHLORIDE METHYL ETHYL KETONE METHYLENE CHLORIDE MIXED ACID NAPHTHA NAPHTHALENE NICKEL CHLORIDE NITRIC ACID (ALL CONC.) NITROBENZENE OLEUM OXALIC ACID PERCHLORIC ACID PHENOL POTASSIUM SALTS PROPYL ALCOHOL SILVER NITRATE SODIUM BROMIDE SODIUM CHLORIDE SODIUM HYPOCHLORITE SODIUM NITRATE SODIUM SULFATE SULFUR DIOXIDE SULFURIC ACID (ALL CONC.) SULFUROUS ACID TANNIC ACID THIONYL CHLORIDE TOLUOL TRICHLOROETHYLENE TRIETHANOLAMINE TURPENTINE UREA VINYL ACETATE WATER (DISTILLED) ZINC CHLORIDE ZINC SULFATE

Any chemist can tell you why even the most active of acids slide through PYREX Pipe without biting.

This heavy-duty borosilicate glass just will not react with any chemical except hydrofluoric acid and several of the hot concentrated alkalis.

Any accountant could give you another good reason for using PYREX Pipe . . . it actually costs less than many other materials when all installation costs are considered—much less when you include maintenance. If this seems an extreme statement, one of our salesmen can give you specific figures on your plant piping.

**You can see through it.** You can see inside this pipe, spot trouble immediately, locate it exactly.

**You can work hot with it.** Run chemicals up to 450° F., even with thermal shocks as high

as 200° F. without buckling or breakage.

**It's tough, easy to install.** Your own plant men can install PYREX Pipe, usually much faster than metal pipe, because it's lightweight, takes only half as many hangers.

**Heat exchangers and drainlines, too.** We also make a complete line of PYREX brand heat exchangers and laboratory drainlines and fittings.

See our insert in the 1960 Chemical Engineering Catalog. For complete information, write to the address below for bulletins, or contact your Corning salesman.

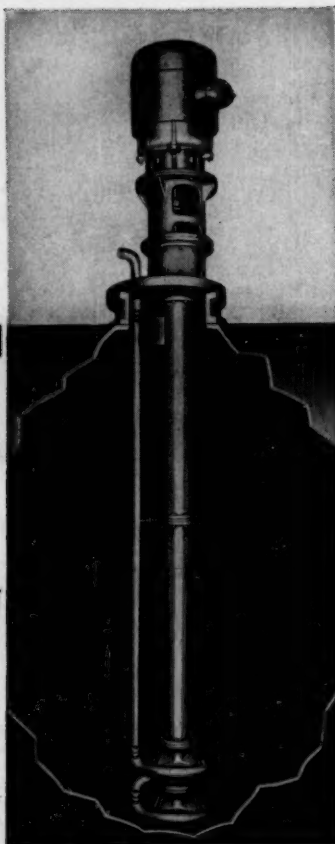


**CORNING GLASS WORKS**

8902 Crystal St., Corning, N. Y.

CORNING MEANS RESEARCH IN GLASS

Lawrence 2-Stage Vertical Pump for Pumping Liquid Chlorine out of Tanks.



# **PUMPS**

## **to handle LIQUID CHLORINE**

Pumping liquid chlorine calls for more ingenuity and engineering skill than is available from the average pump manufacturer. Formerly it was pumped pneumatically. This method was attended by a considerable loss of chlorine because the moisture in the air formed hydrochloric acid. A further complication was the corrosive action of the acid vapors.

To overcome this, Lawrence engineers in collaboration with manufacturers of chlorine, developed a pump with a special packing box which prevents any contamination of the chlorine or corrosion of any of the equipment and also prevents the escape of the chlorine fumes to the atmosphere.

For over 80 years Lawrence has been making pumps to handle every acid or chemical fluid used in industry. If you have a particularly difficult chemical pumping problem, we can save you both time and money. Write us the pertinent details, no obligation.

Send for Bulletin 203-8 for a complete summary of chemical and process pump data.



# **LAWRENCE PUMPS INC.**

371 MARKET STREET, LAWRENCE, MASS.

### **CPI NEWS BRIEFS . . .**

lb./yr. carbon black plant near Buenos Aires. It will cost \$4 million, is expected to be in operation by late this year. Output will satisfy domestic demand, and surplus will be exported to other Latin-American countries.

**China:** Chinese Petroleum Corp. and Socony Mobil Oil Co., Inc.'s Mobil Chemical Co. Div. have submitted a joint application to the Republic of China's government for erection of a 100,000-metric ton/yr. urea plant at Taiwan, Formosa. This proposed investment, still subject to approval by boards of both companies as well as by the government, would be the largest single foreign investment in China.

**Canada:** Consolidated Mining & Smelting Co. is planning a \$3-million reorganization of its zinc-treating system at Trail, B. C. Company spokesmen say the project is not to increase capacity, but rather to realign the plant's metallurgical processes.

**Ireland:** Shamrock-Avoca Ltd. is a new company that has been formed by Irish, Belgian and Canadian interests to establish a \$11.2-million chemical plant at Kilmokea, County Wexford. Plant will treat pyrites from nearby mines at Avoca to produce 115,000 long tons/yr. sulfuric acid. The acid will be combined with imported phosphate rock to make superphosphates. Compound fertilizers will also be made, with the aid of ammonia from a nitrogenous fertilizer plant that is planned for the country's midlands. Byproduct ore material from the Kilmokea facility's operations will either go to a steel works at Cork or be exported to England and continental Europe.

Companies involved in the venture are Shamrock Superphosphates of Wicklow, a joint Irish-Belgian firm; St. Patrick's Copper Mines, a Canadian-owned firm that is owner of the mine at Avoca; and other, undisclosed Canadian groups. Production is scheduled to start in '63.

# NEW! VAR SOL STAYS SWEET!



"It's here my friends, new improved Varsol... the solvent with long-lasting freshness. Produced by a unique, new Esso hydrofining process, today's Varsol retains its efficient solvency, yet keeps its fresh, sweet smell locked in... even after long storage or many processings in your plant. Like all Esso solvents, new improved Varsol reaches your plant fresh, uniform, and on schedule from modern, conveniently located storage facilities. Don't hesitate to call on your local Esso Representative for further information and expert technical assistance. Or write: 15 West 51st Street, New York 19, New York. (And tell 'em Nosey sent you!)" *Nosey*

ESSO STANDARD, DIVISION OF  
HUMBLE OIL & REFINING COMPANY





# WHERE CAN A COMPANY OBTAIN INFORMATION ON THE MOST MODERN METHODS OF CONTINUOUS DRYING?

*One company recently placed orders for nearly \$3,000,000 worth of Surface continuous dryers.*

*More and more chemical and food plants are using the modern services of Surface Combustion engineers.*

*Purchasers are demanding dryers custom designed to fit the particular problem rather than "Hand-me-downs" to complete the plant automation.*

*Surface Combustion engineers have many advantages to offer: Kathabar Humidity Conditioning Units; Air heaters instead of individual burners; Laboratory Facilities for testing customers' products; large organization of engineers experienced in mechanical and structural design.*

## GET FACTS



59-4

### **SURFACE COMBUSTION**

A division of Midland Ross Corporation  
2380 Dorr Street, Toledo 1, Ohio

Send facts on Kathabar systems for following application:

name & title .....  
company .....  
street .....  
city ..... zone ..... state .....

In Europe: NEDAIRCO, The Hague. In Japan: CHUGAIRO, Osaka.

## Convention Calendar

### February

20-23. Technical Assn. of the Pulp and Paper Industry, 46th Annual Meeting, Hotel Commodore, New York, N. Y.

26-2. Society of Petroleum Engineers of the American Institute of Mechanical Engineers, Annual Meeting, Chase & Park Plaza Hotels, St. Louis, Mo.

26-1. American Institute of Chemical Engineers, Petroleum and Petrochemical Exposition, National Meeting, Municipal Auditorium, New Orleans, La.

26-1. American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc., 90th Annual Meeting, Chase Park Plaza & Ambassador Hotels, St. Louis, Mo.

### March

5-9. The American Society of Mechanical Engineers and The U. S. Department of Defense, 6th Annual Gas Turbine Conference and Products Show, Shoreham Hotel and Pentagon, Washington, D. C.

7-9. The Material Handling Institute, The Industrial Truck Assoc., Spring Meeting, Sheraton Blackstone Hotel, Chicago, Ill.

13-17. National Assn. of Corrosion Engineers, Annual Conference & Corrosion Show, Statler Hotel, Buffalo, N. Y.

15-17. National Gasoline Assn. of America, 40th Annual Convention, Baker Hotel, Dallas, Tex.

17-18. Technical Assn. of the Pulp and Paper Industry, American Society for Quality Control, Chemical Div., Course in Evolutionary Operation, Dinkler-Plaza Hotel, Atlanta, Ga.

20-24. American Society of Metals, 12th Western Metal Congress, Ambassador Hotel, and Western Metal Exposition, Pan-Pacific Auditorium, Los Angeles, Calif.

20-31. Purdue University, 9th Annual Industrial Packaging Course, LaFayette, Ind.

21-23. Illinois Institute of Technology and American Society of Mechanical Engineers, American Power Conference, Sherman Hotel, Chicago, Ill.

27-29. Midwest Gas Assn., Annual Meeting & Convention, Sheraton-Fontenelle Hotel, Omaha, Neb.

#### April

5-7. Department of Health, Education and Welfare, Public Health Service, Robert A. Taft Sanitary Engineering Center, Symposium on Ground Water Contamination, Sheraton-Gibson Hotel, Cincinnati, Ohio.

6-7. American Society of Mechanical Engineers, Management Engineering Conference, Statler-Hilton Hotel, New York, N. Y.

9-13. American Society of Mechanical Engineers, Oil & Gas Power Conference and Exhibit, Jung Hotel, New Orleans, La.

10-11. American Institute of Electrical Engineers, Rubber and Plastics Industries Conference, Sheraton Hotel, Akron, Ohio

10-11. American Society of Mechanical Engineers, Maintenance & Plant Engineering Conference, Bancroft Hotel, Worcester, Mass.

10-11. The Combustion Institute, Western States Section, 1961 Spring Meeting, Aeronutronic, Newport Beach, Calif.

10-12. Western Petroleum Refiners Assn., 49th Annual Meeting, Grenada Hotel, San Antonio, Tex.

10-13. American Management Assn., National Packaging Exposition, McCormack Place, Chicago, Ill.

10-14. Greater New York Safety Council, 31st Annual Safety Convention & Exposition, Statler-Hilton Hotel, New York, N. Y.

11-12. American Institute of Electrical Engineers, Materials Handling Conference, Pick-Congress Hotel, Chicago, Ill.

11-13. American Society of Lubrication Engineers, Annual Meeting & Exhibit, Bellevue-Stratford Hotel Philadelphia, Pa.

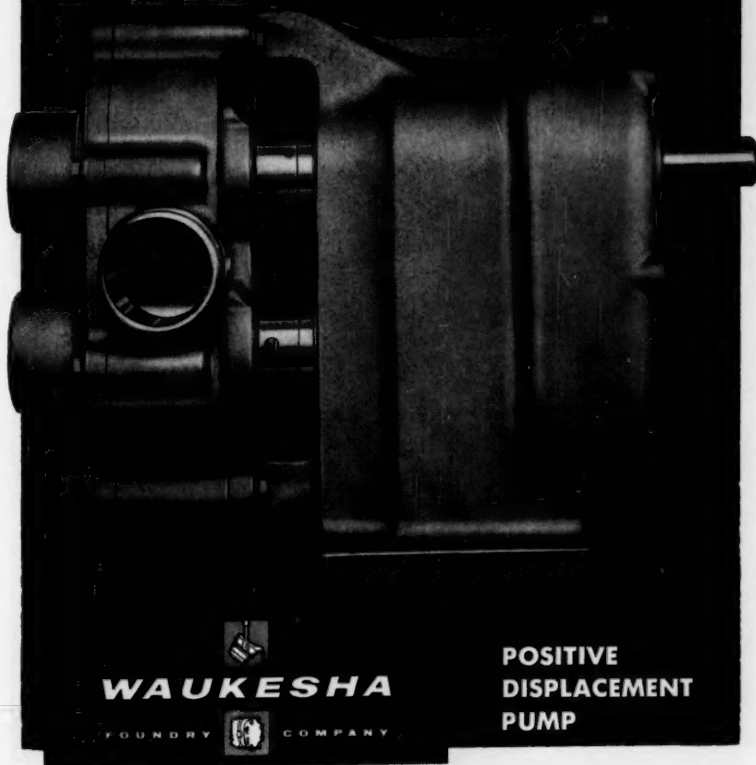
11-13. Air Force Research & Development Command, Conference on Ultrapurification of Semiconductor Materials, New England Mutual Hall, Boston, Mass.

12-14. Metallurgical Society, Society of Petroleum Engineers, Society of Mining Engineers, 1st International Symposium on Agglomeration, Sheraton Hotel, Philadelphia, Pa.

13-14. Oklahoma State University, Heat Transfer Conference, Stillwater, Okla.

17-19. Purdue University, Conference on Manufacturing Automation, Lafayette, Ind.

**greater output than any  
other industrial pump**



#### ENGINEERING SERVICE

Waukesha offers a competent staff of engineers to aid you in your pumping problems. Representatives in all major cities, territorial managers, and direct factory representatives.

A new "Waukesha" designed and engineered to deliver less turbulence, pulsation, aeration and agitation on products of high or low viscosity . . . a smoother operation which assures longer life, less maintenance.

- twin-balanced impellers
- single or dual mechanical seals (John Crane)
- interchangeable packing gland or mechanical seal construction
- self priming
- shaft supported by three heavy-duty bearings to eliminate deflection
- iron pipe or flange-type connections
- quick disassembly of pumping head
- helical timing gears
- off-shelf replacements
- max. capacity—100 G.P.M.; max. pressure—200 P.S.I.

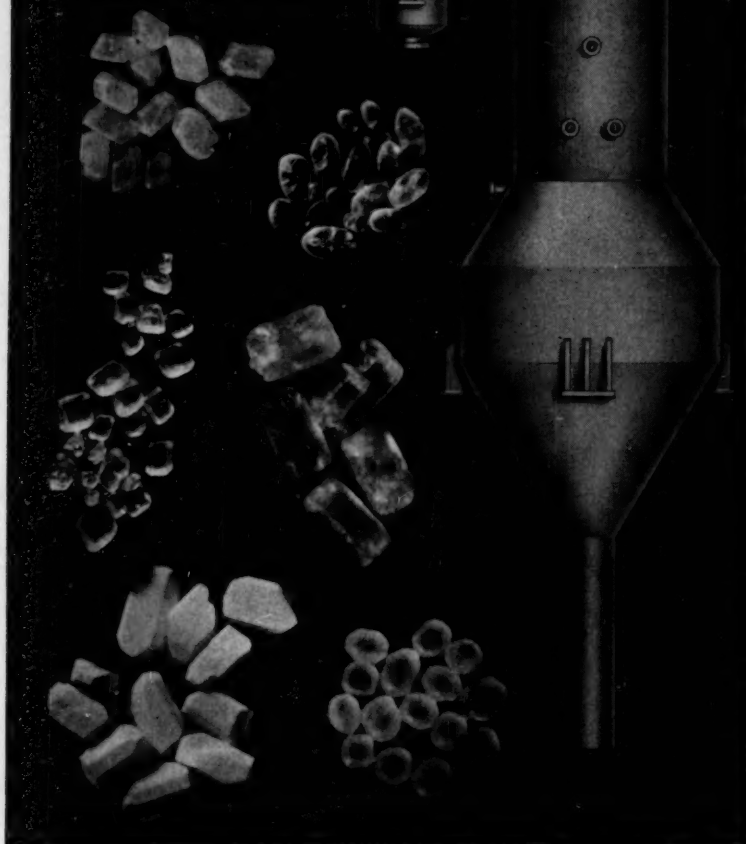
Write for Catalog P302

#### **WAUKESHA FOUNDRY COMPANY** Dept. # 91A, Waukesha, Wisconsin

International Sales: FMC International, San Jose, California (Cable Address: FOODMACHIN)

positive displacement pumps . . . centrifugal pumps . . . stainless steel valves and fittings . . . corrosion resistant castings

## FOR LARGE, UNIFORM CRYSTALS



Swenson's new Draft Tube Baffle Crystallizer is the most advanced equipment yet designed for production of large, uniform crystals required in fertilizers and similar materials. Low first cost and long operating cycles, plus unusually simple control of operation, offer high product quality at significant production economies.

**Bulletin SW-206, Draft Tube Baffle Crystallizers**, describes operation in full detail. Write for it today: Swenson Evaporator Company, 15669 Lathrop Ave., Harvey, Illinois. In Canada: Whiting Corporation (Canada) Ltd., 350 Alexander Street, Welland, Ontario, Canada.



PROVED ENGINEERING FOR THE PROCESS INDUSTRIES SINCE 1889

# SWENSON

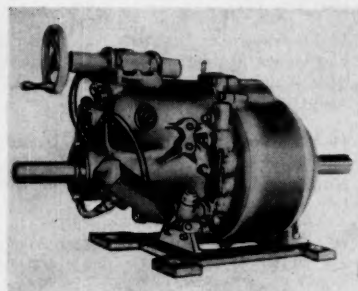
WHITING — MANUFACTURERS OF CRANES; TRANBEAM® HANDLING SYSTEMS; PRESSUREGRIP; TRACKMOBILES,® FOUNDRY, AND RAILROAD EQUIPMENT



## MORE NEW EQUIPMENT . . .

(continued from page 112)

taking maximum pressures of either 7,500 or 30,000 psi. Pump cylinder is completely evacuated by every stroke, which makes for efficient pumping of highly compressible liquids.—American Instrument Co., Inc., Silver Spring, Md. 112D



### Speed reducer

**Hydraulic transmission unit is designed for heavy duty.**

Designed for continuous operation, this new hydraulic transmission provides any speed from 0 to 1,600 rpm. under high-torque, heavy-duty operation. Compressors, centrifuges, blowers, pumps and mixers are potential applications.

Coupled to any 2-to-10 hp. motor (or 20-hp. gas engine), the transmission permits precise speed selection by rotation of a hand wheel. Remote-control selection is also possible.

Compact (22 × 13 × 16 in.) and lightweight (100 lb.), the unit incorporates ball and roller bearings throughout.—Roberts Electric Co., Chicago. 206A

### Memory computer

**Third-generation automation employs thin-film memory.**

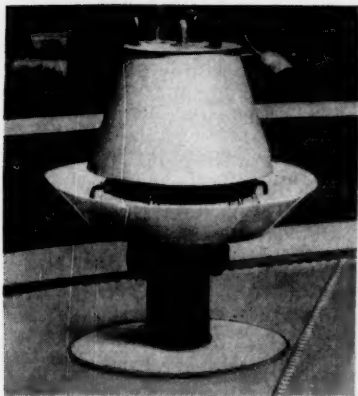
Remington Rand's Univac 1107 Thin-Film Computer has a memory as long as its name. It's the only

computer to employ both thin magnetic film memory and ferrite-core memory.

An advanced solid-state data processing system, it's the first of the third-generation computers. Brand-new features include: 16 arithmetic registers, 15 index registers with automatic incrementation, and partial-word transfer capabilities. As a result, cycle time (time required to read and write information) is only 0.6 microseconds, as compared with the 1.5-microseconds cycle time of the most advanced previous computer design.

The new computer scans its 65,536-word core memory up to 500,000 times per second, its film memory more than 1,000,000 times per second in normal operation.

A versatile input-output section can accommodate a wide range of peripheral equipment, enables the computer to communicate with such other devices as analog-to-digital and digital-to-analog converters, radar and tracking systems. Floor space of the computer without accessories is 150 sq. ft. —Remington Rand Univac, New York. 206B

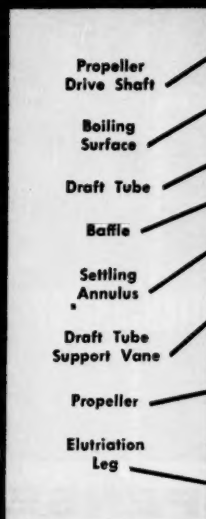


### Vapor vent

Antipollution unit sends fumes from tanks high into the air.

Storage-tank gases can be vented high into the air by a device that mounts on the pressure

## SWENSON DTB CRYSTALLIZER



### BASIC PRINCIPLES OF THE DRAFT TUBE BAFFLE CRYSTALLIZER

- Growing crystals are brought to boiling surface where super-saturation is most intense and growth most rapid
- Sufficient seed surface is maintained at boiling surface to minimize harmful salt deposits on equipment surfaces
- Low head losses in internal circulation paths permit large flows at low power requirements
- Optimum fines removal is possible because of high flow-rate past separation zone

Swenson designs three types of DTB Crystallizers — Cooling, Evaporative and Reaction. To determine the one best suited to *your* needs, write to: Swenson Evaporator Company, 15669 Lathrop Ave., Harvey, Illinois. In Canada: Whiting Corporation (Canada) Ltd., 350 Alexander Street, Welland, Ontario, Canada.

PROVED ENGINEERING FOR THE PROCESS INDUSTRIES SINCE 1889

# SWENSON

WHITING — MANUFACTURERS OF CRANES; TRANBEAM® HANDLING SYSTEMS; PRESSUREGRIP; TRACKMOBILES,® FOUNDRY, AND RAILROAD EQUIPMENT





# ARE

## HOLDING DOWN PRODUCTION RATES?

### ... ADD MARASPERSE\*

(usually in dry powder form)  
to make slurries thinner and easier to handle.

The Maraspersees keep small particles of insoluble solids dispersed, won't let them flocculate or "get together" in water. In slurries this means greater fluidity because smaller particles flow past one another more readily than do larger ones.

Only a little Marasperse is required to achieve a workable slurry. Usually less than 3% (based on the weight of the solids in an aqueous system) will do the job for you.

By the way, if your products have to be suspended in water for use, you can also avoid customer complaints about sedimentation by using Maraspersees in your formulations. Pigment dispersions, for example, need only 1 or 2% Marasperse . . . likewise, ceramic clay dispersions and dyestuff pastes. What's more, Maraspersees are really inexpensive, too!

It's easy to determine whether or not a Marasperse can be helpful to you. A few quick tests in your laboratory will provide the answer. Write us about your viscosity or dispersion problems. We'll send you suitable Marasperse samples for evaluation, together with descriptive literature.

## MARATHON

A Division of American Can Company  
CHEMICAL SALES DEPARTMENT

\*Registered U. S. trademark

MENASHA, WISCONSIN



MARATHON • A Division of American Can Co.  
CHEMICAL SALES DEPT. • MENASHA, WIS.

Please send Information File No. E-21 ☐, Samples ☐ of MARASPERSE for use in

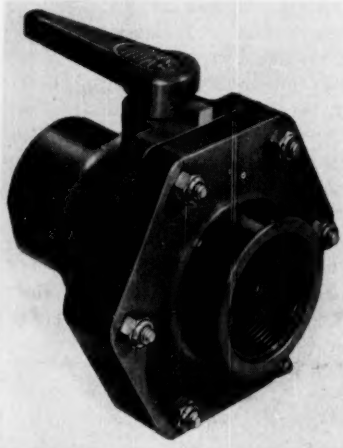
NAME \_\_\_\_\_  
TITLE \_\_\_\_\_  
COMPANY \_\_\_\_\_  
ADDRESS \_\_\_\_\_

Please attach to your company letterhead.

### NEW EQUIPMENT . . .

relief valve of exhaust piping. As product is pumped into the tank for storage, residual fumes are directed into the atmosphere at speeds of 13-25 mph., shooting high above surrounding roofs.

Successfully tested under snow and freezing conditions, vapor vent diffuses snow, and drains water through bottom holes. It is said that 80% or more of the storage-tank fumes are vented by the unit, which comes in seven pipe-diameter sizes ranging from 2 to 12 in.—The Johnston & Jennings Co., New York. 207A



### Plastic ball valve

Positive shutoff provided up to 125 psi. with 1/4-turn of handle.

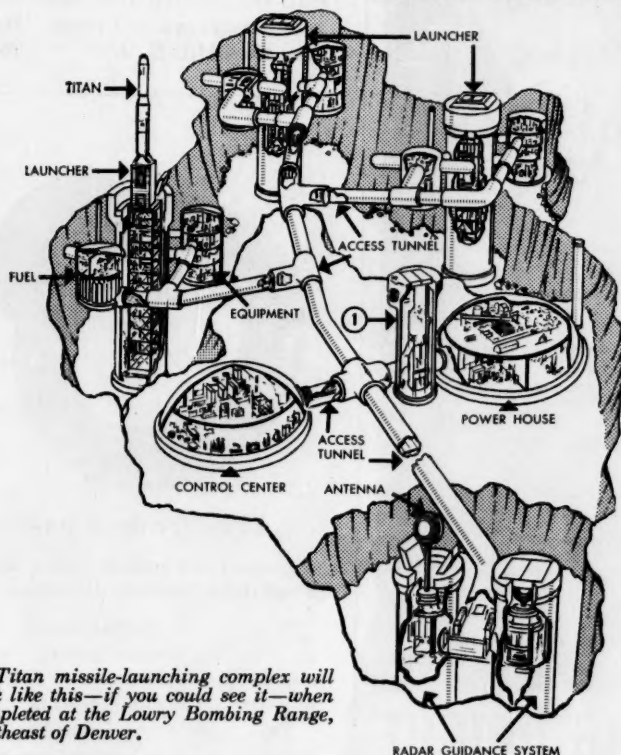
Unobstructed, straight-through design, permitting full flow with no drop in pressure, is incorporated in a new polyvinyl chloride ball valve now available in 3-in. size. Valve shuts off tight against pressures to 125 psi., can handle fluids up to 140 F.

Valve's coupling-like assembly simplifies installation: simply fit each half of valve to pipe ends, then reassemble. Cleaning and maintenance can be done without removing the valve from the line.

According to the manufacturer, valve offers maximum resistance to most corrosives, is dimensionally stable. It is said to meet the proposed ASTM specifications, have a

# PUMPAGE

Goulds news about pumps for process industries



A Titan missile-launching complex will look like this—if you could see it—when completed at the Lowry Bombing Range, southeast of Denver.

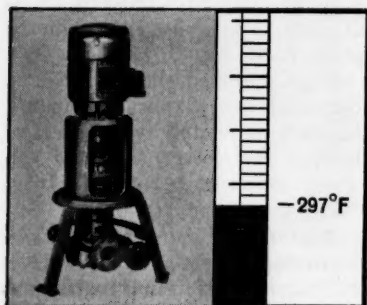
## Goulds ductile iron pumps help build TITAN MISSILE MUSCLE

Deep under the Colorado earth, two gigantic Titan missile bases are taking shape. Powerhouse and control center are vast domed structures. Three two-story structures will store fuel. Four-story cylinders will house monitoring and other operating equipment.

Immense and complex, the bases require a wide variety of pumping services. Goulds, the major pump supplier, is building hundreds of units—from vertical sump pumps to high-temperature, high-pressure units.

Many of the pumps *must* be able to stand severe shock so we are making these, or their critical parts, of ductile iron. Castings range from ½ lb. to over 1800 lbs., making up probably the largest order for ductile iron pumps ever placed.

If you'd like to know why ductile iron has unusual resistance to stress, impact, and high pressures, send for Bulletin 765.7.

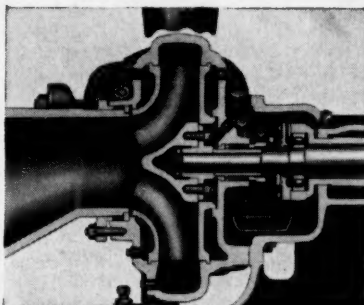


### How to pump cryogenics

One company pumps liquid oxygen at -297°F with this process pump.

Model 3181's basic design especially fits it for low-temperature pumping. Casing arrangement of suction limits pressure on column, bearings and seal to vessel pressure only. Special magnetic mechanical seal seals shaft.

Cryogenics raise special problems in selecting pump design, materials, and seal. Our engineers, experienced in these applications, can help you. Write us.

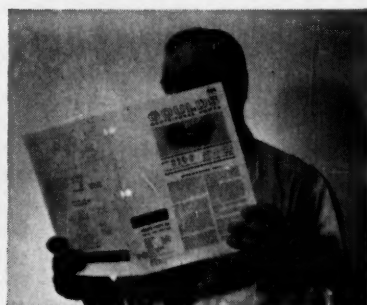


### Cotton pickin' pump

Nine Model 3135s pump cotton linter stock in a smooth flow for Southern Chemical Cotton Co.

The fine cotton fibers can't clog the open end suction impeller. Ejector vanes on back wall of impeller follow curvature of main vanes, prevent entrance and jamming of stock between wall and stationary sideplate. There is no impeller nut or other obstruction at the impeller eye to catch fibers.

For specifications and performance data, send for Bulletin 723.1.



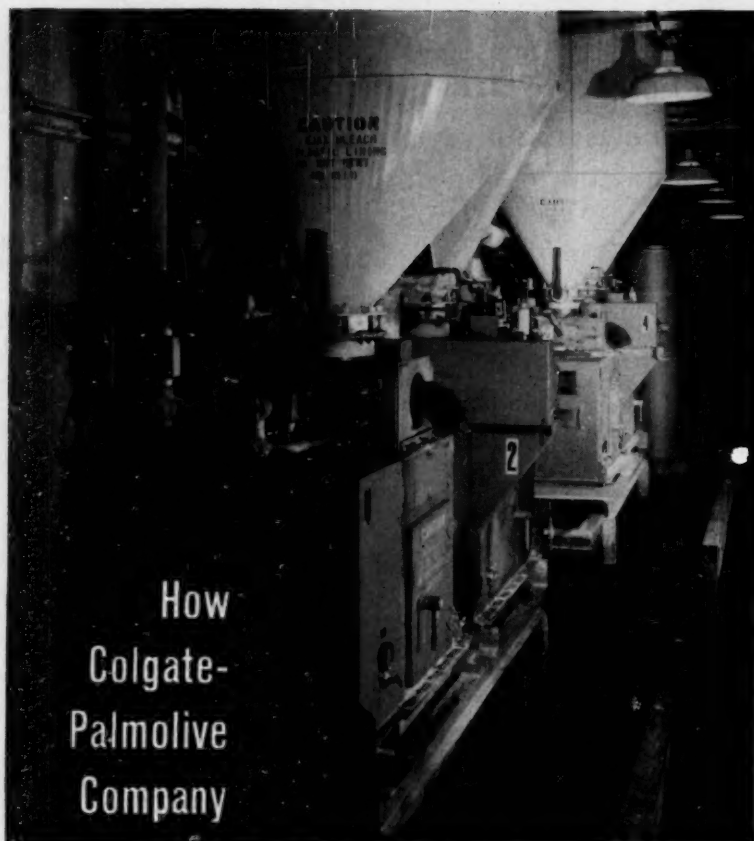
### Now... small-capacity pump for chemicals and slurries

Handles up to 115 gpm of corrosive chemicals, thick or abrasive slurries at heads to 150 ft.

Of single-stage side-suction open-impeller design, Model 3199 has hydraulically balanced impellers with ejector vanes on back wall to keep out solid material and reduce stuffing-box pressure. Bearings are isolated in cooling chamber.

For specs, ratings and other data, write for Bulletin 720.5. Goulds Pumps, Inc., Dept. CE-21, Seneca Falls, New York.

**GOULDS  PUMPS**



How  
Colgate-  
Palmolive  
Company

## KEEPS AJAX CLEANING BRIGHT

...with  
**Richardson  
Automatic  
Scales**

Housewives like AJAX. It leaves sinks and tubs so sparkling clean and bright... and a quality-conscious management knows their sales are safe as long as they get exactly the right amount of bleach in each batch. Too little affects cleaning qualities. Too much creates unpleasant odors and a hazard to tender skin.

Colgate-Palmolive Company depends on Richardson Automatic Scales for this all-important quality control job—getting just the right amount of bleach per batch. Richardson's know-how in all kinds of process automatic weighing comes from thousands of installations in plants all over the world.

Richardson means reliability... the ability to stand the gaff of day in, day out operation. Why not call in a Richardson automatic weighing specialist for your application. Phone or write Richardson Scale Company, Clifton, N. J.



Send for free  
technical bulletin

# Richardson

Sales and service Branches in Principal Cities.  
Also manufactured in England, France  
and Australia. Richardson Scales conform  
to U. S. Weights and Measures H-44  
for your protection.

MATERIALS HANDLING BY WEIGHT SINCE 1902

### NEW EQUIPMENT . . .

tensile strength of 8,500 psi. Tight seals are obtained with Teflon seats and neoprene O-rings.—Hoke Inc., Cresskill, N. J. 208A



### Pressure-drop gage

High-pressure unit is based on diaphragm capsule deflection.

Said to be damageproof, this differential-pressure gage withstands the application of full-line pressure in either direction.

Two models are available, both rated for 70-psi. operating pressure: one measures pressure drops of as much as 10 in. H<sub>2</sub>O, while the other handles a  $\Delta P$  of 15 in. H<sub>2</sub>O.

Gage movement is actuated by deflection of a diaphragm capsule, which is protected by a system of built-in restrictors, balanced volumes, and pressure relievers. Originally developed for use as flow indicators, the gages are effective as orifice meters and liquid-level indicators. — National Instrument Laboratories, Inc., Washington, D. C. 210A

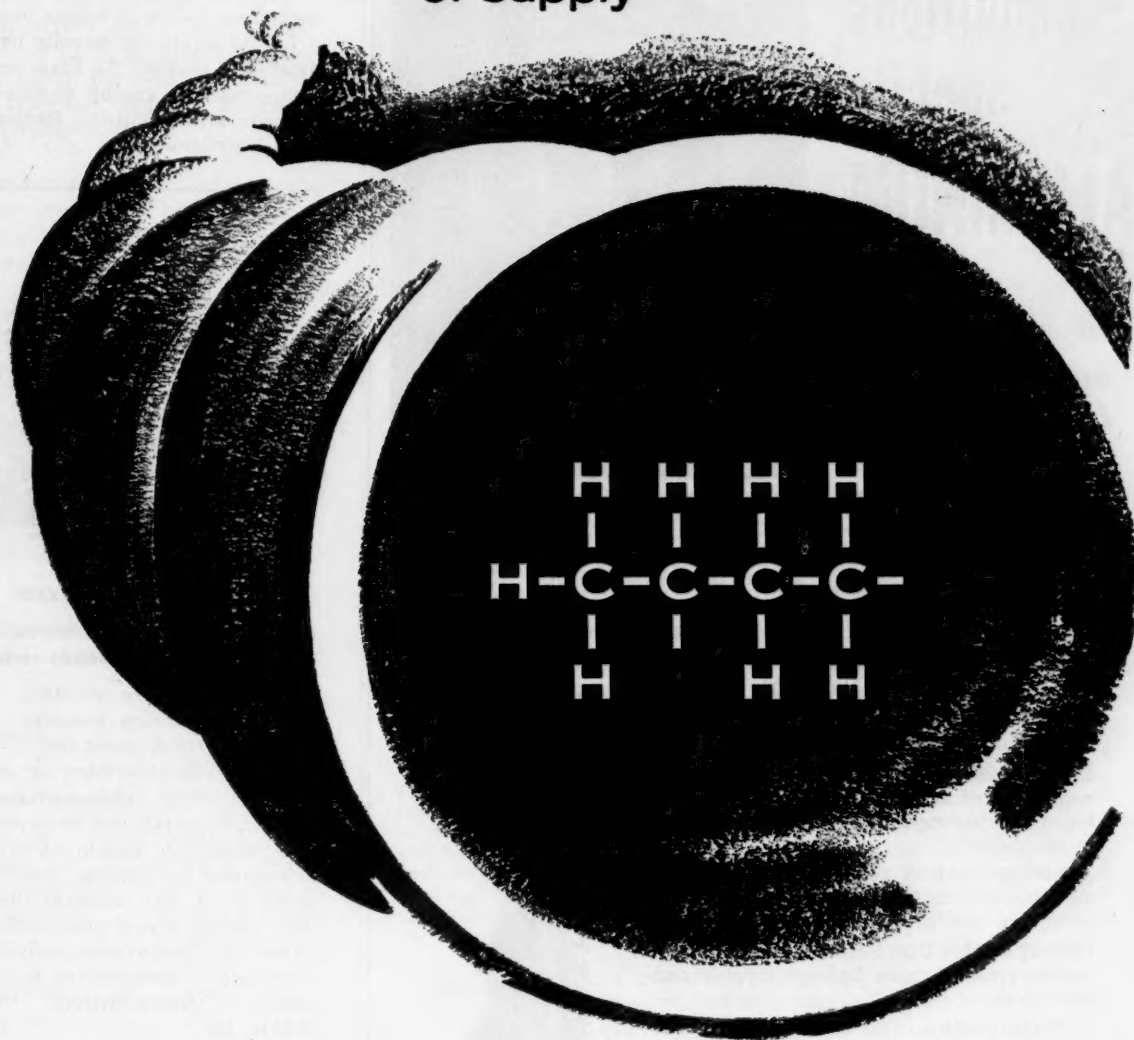
### Thickness gage

Device uses beta, gamma rays to take metals measurements.

For measurement or process control, this noncontacting gage will give you both thickness and density of most solids—and even some liquids—by bouncing beta or gamma rays off the material.

Accuracy depends both on the material being measured and on

Celanese 25-million lb.  
production capacity for  
1,3-BUTYLENE GLYCOL  
gives the process industry  
its first volume source  
of supply



Now, there's enough of this versatile diol to meet your needs—*promptly* and *economically*! Celanese 1,3-butylene glycol has many advantages in many applications. Its longer chain length and molecular configuration open new possibilities for producers of plasticizers, of alkyds, polyesters, and polyurethanes. This glycol, like other Celanese glycols, is now available in tank cars, compartmented cars, and drums. Write for technical data, outlining your

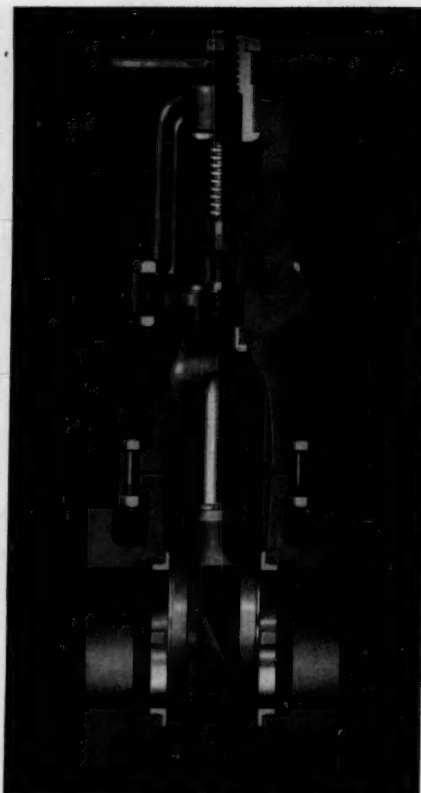
application, to: Celanese Chemical Company,  
Dept. 553-B, 180 Madison Avenue, New York 16, N. Y.

Celanese®  
Celanese Chemical Company is a Division of Celanese Corporation of America.  
Canadian Affiliate: Canadian Chemical Company Limited, Montreal, Toronto, Vancouver.  
Export Sales: Amcel Co., Inc., and Pan Amcel Co., Inc., 180 Madison Avenue, New York 16.





For severe  
corrosive  
conditions  
specify  
**ALUMINUM  
GATE  
VALVES**  
by Darling



Unique revolving disc feature assures maximum life under the most exacting service conditions. Friction between wedges is reduced to a minimum. Horizontal and vertical equalization of wedging pressure is assured.

Handling corrosive chemicals such as hydrogen peroxide, ammonium nitrate, acetic acid, concentrated nitric acid? Darling Aluminum Gate Valves give you longer life, cut maintenance costs, under these and other severe service conditions. Here's why:

Darling metallurgical engineers have thoroughly tested and standardized on the most highly corrosion-resistant aluminum alloys in use today.

Accurate casting control and precision assembly reduces friction and wear, provides maximum ease of operation.

Darling Double Disc Parallel Seat principle assures freedom from leakage, trouble and downtime.

Darling aluminum alloy valves are available in sizes from 1/2" through 24". Write us about your requirements and service conditions.



**DARLING VALVE & MANUFACTURING CO.**

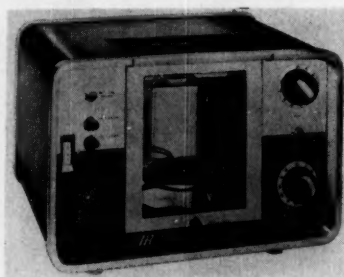
Williamsport 3, Pa.  
Manufactured in Canada by  
Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ont.

**NEW PROCESSES . . .**

the ray used to measure it. For example, gamma will take steel dimensions to  $\pm 0.001$  in.; beta will give you foil widths to within a few micro-inches.

High speed of response—as quick as 10 millisecon.—permits accurate control of conveyor-like operations. Material moving 5,000 ft./min. can be inspected and reported on before it moves one ft.

Liquid levels can usually be indicated to within 1%. Flaw detection, dimension gaging, and weighing, are also possible.—Radionics Inc., Norristown, Pa. 210B



**Moisture analyzer**

Unit automatically measures, reports moisture or solids content.

By torsion-wire rotation, this pushbutton device measures and reports percent moisture or percent solids in laboratory or onsite samples. Both light- and heavy-density materials can be serviced, and no specific weight of sample is required for testing. Sample is dried in a far infrared heater only during preset time-cycle, so danger of inaccuracies caused by scorching or underdrying is eliminated. — Moore-Milford Corp., Skokie, Ill. 212A

**Briefs**

Die-feeder for rotary tabletting presses allows dry-blended powders to be fed directly into a press and tableted without preparatory steps. Feeder also de-aerates

light, fluffy material, increasing the density of the tablets and improving their strength.—F. J. Stokes Corp., Philadelphia. 212B

**Particle-size counter** works in range from below 1 to above 200 microns. Within 10-sec. counting period, device produces full size-range data, presenting counts as "greater than stated size" or "between stated size." Results are delivered as either multiple-channel readout, printout or mass-per cent graphout.—Coulter Electronics, Chicago. 213A

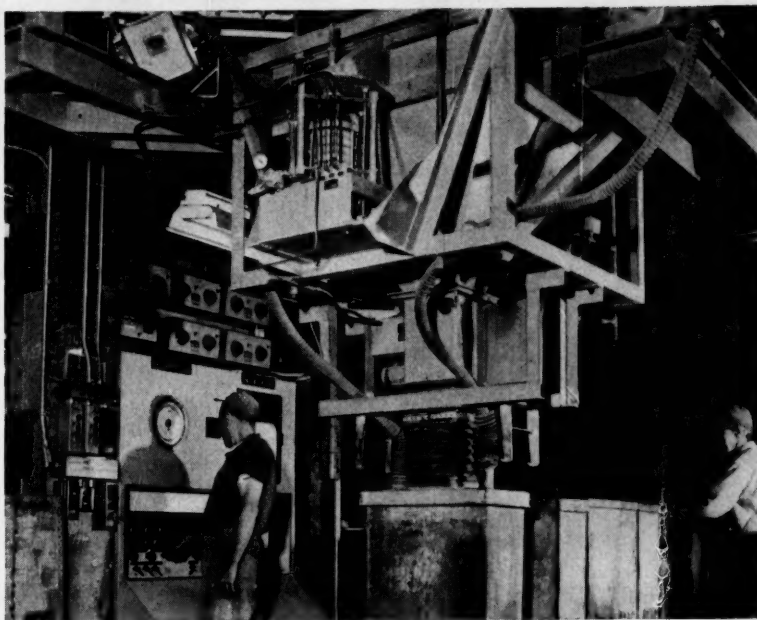
**Transformer**, in conjunction with silicon rectifiers, provides constant but infinitely adjustable motor speeds on d.c. shunt-type motors directly from a.c. power supply. Called Reactron, device automatically regulates voltage and phase angle with change in motor load, hence motor may be operated continuously at full-load torque at all speeds, and up to three times full-load torque intermittently.—Vee-Arc Corp., Westboro, Mass. 213B

## Equipment Cost Indexes . . .

	Sept. 1960	Dec. 1960
<b>Industry</b>		
Avg. of all .....	237.4	237.3
<b>Process Industries</b>		
Cement mfg. ....	231.7	231.6
Chemical .....	238.6	238.2
Clay products .....	225.6	225.1
Glass mfg. ....	225.3	224.8
Paint mfg. ....	229.1	229.4
Paper mfg. ....	229.9	229.4
Petroleum ind. ....	234.0	234.3
Rubber ind. ....	237.9	237.1
Process ind. avg. ....	236.2	236.1
<b>Related Industries</b>		
Elec. Power equip. ....	240.2	238.3
Mining, milling .....	240.0	239.5
Refrigerating .....	267.7	268.0
Steam power .....	224.3	224.5

Compiled quarterly by Marshall and Stevens, Inc. of Ill., Chicago, for 47 different industries. See Chem. Eng., Nov. 1947, pp. 124-6 for method of obtaining index numbers; April 4, 1960, pp. 149-50 for annual averages since 1913.

## AT CARBORUNDUM...



## Accuracy and Instantaneous Control Response with W & C BATCH-WEIGHING SYSTEMS

Critical formulation standards are maintained at lower cost since Carborundum Company has introduced automatic batching of ingredients at their Perth Amboy, N. J. refractories manufacturing plant. The new automatic system—designed with W & C pre-engineered and laboratory-tested "building block" components—has greatly increased production, reduced labor costs, and decidedly improved the accuracy of batch weight control.

Chief reason for the accuracy of W & C Batch-Weighing Systems is the patented Uniforce flexural frame used in supporting both weigh-hoppers and weight transmitters. These unique flexural frames ensure accurate weighing under all load conditions, resolve every force and moment into a single vertical component applied to the load transducer.

Immediate response to control material flow in any batching operation is provided by the W & C Pneumatic Weight Transmitter, a force-balance instrument delivering a highly reproducible, (1 part in 2000) almost instantaneous signal directly proportional to net weight. No possibility of overshooting specified ingredient quantities. Practically no maintenance, compared with mechanical systems. The W & C scale is dynamically faster than a beam-and-balance or flexural beam system . . . W & C uses air, has no inertial mass to overcome . . . comes into balance sooner than a mechanical system.

For consistently accurate reproduction of bulk material formulations in any batching operation—single ingredient weighing to sequential multi-ingredient proportioning—you can depend on W & C.

### WRITE FOR BULLETINS

Bulletin 30 fully describes W & C Batch-Weighing Systems

Bulletin 14 describes other W & C Automatic Weighing Systems

WC 100



CONVEYOR  
SCALE SYSTEM



CONSTANT-FEED  
WEIGH-HOPPER SYSTEMS



CHECK-WEIGHING  
SYSTEMS



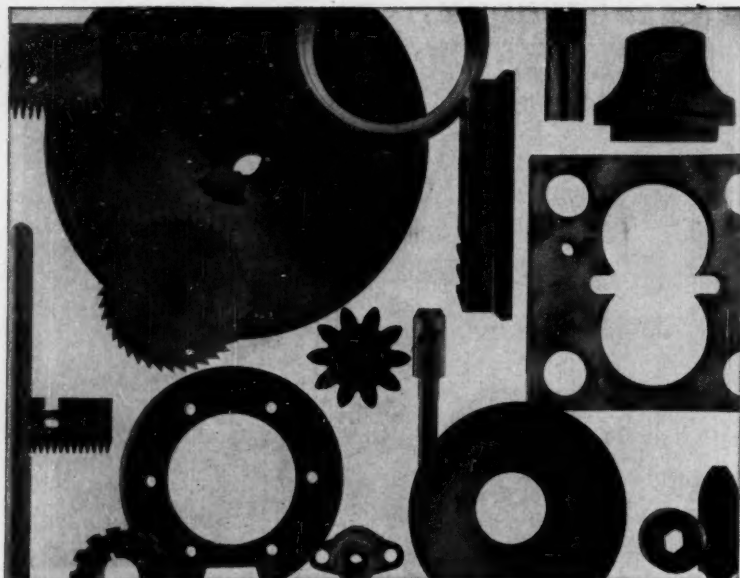
CONTROL PANELS



**Weighing & Controls, Inc.**

Subsidiary of **CompuDyne Corporation**

Industrial Park, E. County Line Road, Hatboro 10, Pa.



Made of Kennametal\* and Kentanium,\* these parts perform better, longer. Punches, dies, seal rings, nozzles, pump parts, temperature sensing elements and hundreds of other critical parts are custom-engineered to solve specific design and materials problems.

## All these parts were problems ...until made of KENNAMETAL

Some of the machine components shown above must function at points of extreme abrasion. Others are subjected to the attack of corrosive fluids... or must retain strength at high temperatures. For longest life under these conditions, they have been made of Kennametal or Kentanium. These two hard carbide alloys can be made in about any shape to solve design problems. When new ideas create new design or materials problems, Kennametal or Kentanium often provide the answer. Chances are one or a combination of the unique properties of these materials can help you carry out some design idea.

### OUTSTANDING PROPERTIES

- An extremely high rigidity—up to 94 million YME (compared with steel's 30 million).
- Density of compositions ranges from 5.7 to over 15.0 gms/cc compared to steel at 7.8.
- Compositions available to resist corrosion-wear conditions encountered with nitric, sulfuric and hydrochloric acids, and sodium hydroxide.
- Kennametal is extremely hard (up to 94 Rockwell A) and out-wears steel as much as 100 times.
- Kentanium retains sufficient strength for continuous operation at temperatures of 2200°F and up to 5000°F for shorter periods.

If you'd like more information, contact a Kennametal Representative or write us direct for Booklets "Properties of Kennametal" and "Proven Uses of Kennametal and Kentanium." KENNAMETAL INC., Department CE, Latrobe, Pennsylvania.

\* Kennametal is the registered trademark of a series of hard carbide alloys of tungsten, tungsten-titanium and tantalum. Kentanium is the registered trademark of a series for applications requiring a lighter weight material, or maximum resistance to temperature extremes.



INDUSTRY AND  
**KENNAMETAL**  
...Partners in Progress

33551

## Technical Bookshelf

### COST ENGINEERING COOKBOOK

COST ENGINEERING IN THE PROCESS INDUSTRIES. ED. BY CECIL H. CHILTON AND THE STAFF OF CHEMICAL ENGINEERING. MCGRAW-HILL BOOK CO., INC., NEW YORK. 475 PAGES. \$11.

Reviewed by John W. Hackney,  
Pan-American Management Ltd.,  
Montreal, Can.

A collection of articles that have appeared from time to time in *Chemical Engineering* magazine, *Cost Engineering in the Process Industries* proves once again that the whole may be greater than the sum of its parts. Individual papers, read at the time of original publication with a moderate degree of interest, gain stature as they find their proper station in the field.

That the book is a collection of individual efforts, coordinated only by order of appearance, constitutes at once its strength and its weakness. Strength, because no single individual could possibly be exposed in a lifetime to the varied experience and data available to the 128 authors. Weakness, because nomenclature and approach lack consistency.

In a collection of this type, there is of course a wide variation in quality, both of material and presentation. Among the many fine contributions, special notice is due to the oft-quoted articles of Hans J. Lang; to almost the entire process equipment section (which may be the most heavily utilized part of the book); and to the articles on piping and pipe insulation. Only a very few items seem to have been added to fill up space—and perhaps they could be of interest in special cases.

Several authors—eg., W. G. Clark, De Lamater, Jelen and Chilton—are represented by more than one article. Each of these "repeaters" has made a special contribution to the advancement of knowledge in the field by writing both well and often.

This should be a most useful volume. In addition to many of the



basic-source articles on the theory of cost engineering, it contains much solid data of the "cookbook" type. Impressive results have been obtained by *Chemical Engineering's* long-range policy of encouraging the development of the "dollar phases" of process engineering.

#### A SYNTHESIS OF THEORY

ISOTOPE EFFECTS ON REACTION RATES. BY LARS MELANDER. THE RONALD PRESS CO., NEW YORK. 177 PAGES. \$6.

*Reviewed by G. J. Mains, Chemistry Dept., Carnegie Institute of Technology, Pittsburgh, Pa.*

This monograph is first of a series entitled "Modern Concepts in Chemistry," which promises to develop conceptual synthesis of various theoretical aspects of our present state of chemical knowledge. It is probably unfortunate for the series that this first volume should do so little developing of the theoretical aspects of isotope effects on reaction rates, becoming instead a critical review, even though a valuable one, of some of the recent research in this field.

In the first third of the book, the author refers the reader to reviews and other monographs for development of the theory of isotope effects, then plunges into the various approximations by which a general expression for the isotope effect is made more tractable. The discussion of these approximations and their correlation on a block diagram are excellent features of the second chapter.

After this too-brief exposé of the theory, the volume treats the equations by which the specific rate constants are evaluated. In most instances, these equations are simply presented and the derivation or limitations are not discussed. In spite of this drawback, the chapter will prove valuable to most readers because it brings together many equations for the evaluation of isotope effects from experimental data.

The next third of the book devotes itself to hydrogen isotope effects. Both this section and the final third, which deals with carbon and heavier atom isotope effects,

# One-day tower cleaning!



## 3 years of soil removed from 55-ft. ethylene scrubber tower by Oakite chemical circulation

What's the fastest way to clean a 55-foot tower?

A midwest chemical plant had this problem recently on an ethylene scrubber tower with an accumulation of three years of iron oxides, oil deposits and sludge.

The local Oakite man analyzed the soil and recommended a specialized cleaner to be circulated through the tower. He also recommended the most efficient solution strength, temperature, and gpm of circulation. He remained on hand for consultation during the hook-up and while cleaning was in progress.

Fifteen hours of chemical circulation followed by six hours of rinse removed every trace of soil. The tower was three years younger... and at a fraction of the cost of manual reconditioning.

On any cleaning problem — towers, tanks, pumps, compressors, exchangers, lines, fittings, valves — call your local Oakite man. Or write for literature and details to Oakite Products, Inc., 16H Rector Street, New York 6, N. Y.

Technical Service Representatives in Principal Cities of U. S. and Canada

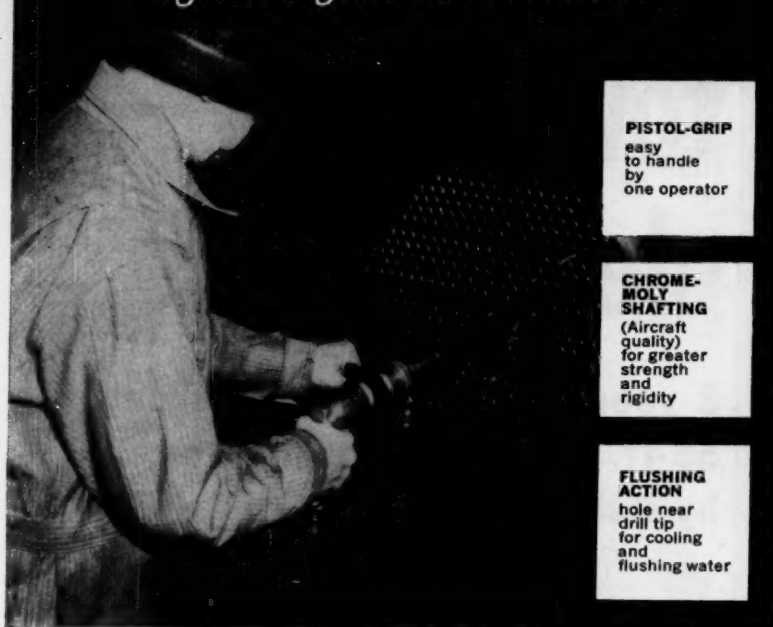
Export Division Cable Address: Oakite





# newest ELLIOTT tube cleaner

*lightweight! air-driven!*



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easy  
to handle  
by  
one operator

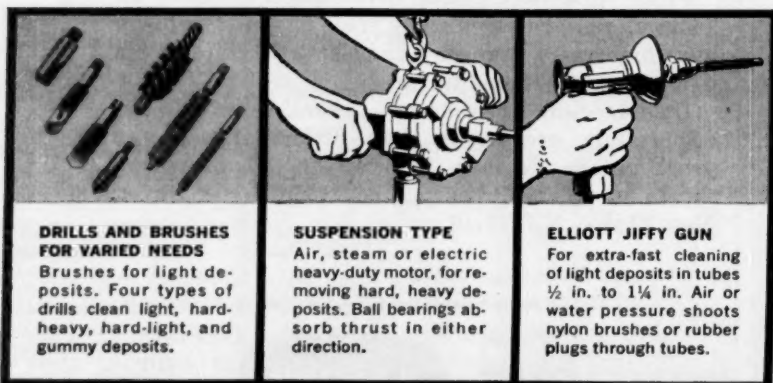
**CHROME-  
MOLY  
SHAFTING**  
(Aircraft  
quality)  
for greater  
strength  
and  
rigidity

**FLUSHING  
ACTION**  
hole near  
drill tip  
for cooling  
and  
flushing water

## for condenser and heat exchanger tubes

Lightweight. Powerful. Air-driven. Trigger-action control with speed governor to prevent shaft-whip. High-speed motor reduced through planetary gears to 1500 rpm. Integral

water-feeding attachment with finger-action valve which controls flow of cooling water into hollow shaft and drill or brush. Built-in oil reservoir. Send for tube cleaner bulletin Y-48.



### DRILLS AND BRUSHES FOR VARIED NEEDS

Brushes for light deposits. Four types of drills clean light, hard-heavy, hard-light, and gummy deposits.

### SUSPENSION TYPE

Air, steam or electric heavy-duty motor, for removing hard, heavy deposits. Ball bearings absorb thrust in either direction.

### ELLIOTT JIFFY GUN

For extra-fast cleaning of light deposits in tubes 1/2 in. to 1 1/4 in. Air or water pressure shoots nylon brushes or rubber plugs through tubes.

## ELLIOTT COMPANY

GENERAL OFFICES: JEANNETTE, PENNSYLVANIA

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TURBINES • GENERATORS • MOTORS • COMPRESSORS • TURBOCHARGERS  
DEAERATING HEATERS • EJECTORS • CONDENSERS • STRAINERS • TUBE CLEANERS

## BOOK SHELF . . .

approach the subject as a selective, critical review of the current literature. Although the author notes that the coverage is far from complete, these pages are well worth reading.

There can be no doubt, however, of the need for a definitive volume that brings together the conceptual advances of Bigeleisen and others so that the student, chemical engineer and research scientist may conveniently study them. Had the present monograph fulfilled this need (or followed another book that did) it would have been much more valuable and timely.

## FUEL CELL—NEW SELL

**FUEL CELLS—Power for the Future.** Fuel Cell Research Associates. P. O. Box 157, Cambridge 38, Mass. 160 pages. \$18.75.

*Reviewed by Edgar K. Sheldon*

This is a highly provocative study. Its premise: there's a "strong possibility" that civilization now stands on the threshold of a new power age—much as it did in 1875, when the internal combustion engine was invented.

And the power is fuel cell, not nuclear.

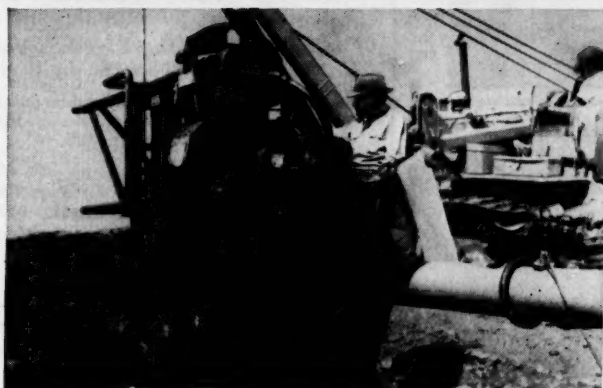
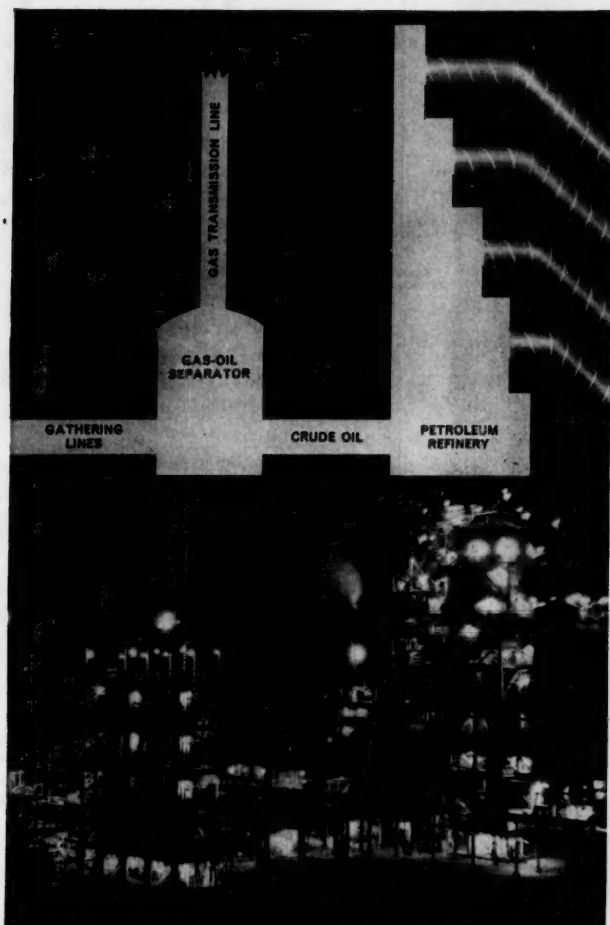
The authors, nine graduate students at the Harvard Business School (five of them engineers; the others, business or liberal arts majors), were given the specific assignment to "research, study, then write a topic report on a subject of interest to the business community." What they came up with is an overly expensive (\$18.75), poorly-bound, photo-offset booklet.

But the material it contains is fascinating.

The researchers begin with a broad, easy-reading discussion of exactly what a fuel cell is, how it works, and why they choose to call it "power for the future." (This section is for the layman.) Then they proceed to a technical review of electrochemical processes, including limitations (not for the layman) and ease into the meat of the research: fuel cell evaluation criteria, fuels developments, present and expected cell units, economic

# Polyken tape protects products lines

for this big  
**Petro Company**



Phillips pipe is cleaned and wrapped by Brodie Construction Company in a single factory-smooth operation. No primer, no drying or cooling. No fumes or fire hazards.

CHEMICAL ENGINEERING—February 20, 1961

*Another convinced user learns  
the money-saving versatility of one of  
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Phillips Petroleum Company chose Polyken No. 960 Extra-Strength Pipeline Tape to protect its products lines. This is why:

- Polyken 960 is a *dependable* pipeline coating. It is easy to handle, simple to apply, resulting in a reliable, quality installation.
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ROCKWELL-REPUBLIC

## V-5 gauges combine small size with big-gauge readability

### TRY THIS "CUTOUT TEST"

For a true demonstration of the readability of Rockwell-Republic V-5 gauges, cut out the actual-size photo at the right. Mount it on any wall or panel board. Step back and see how easily the scale can be read, even from 10 or 12 feet away!

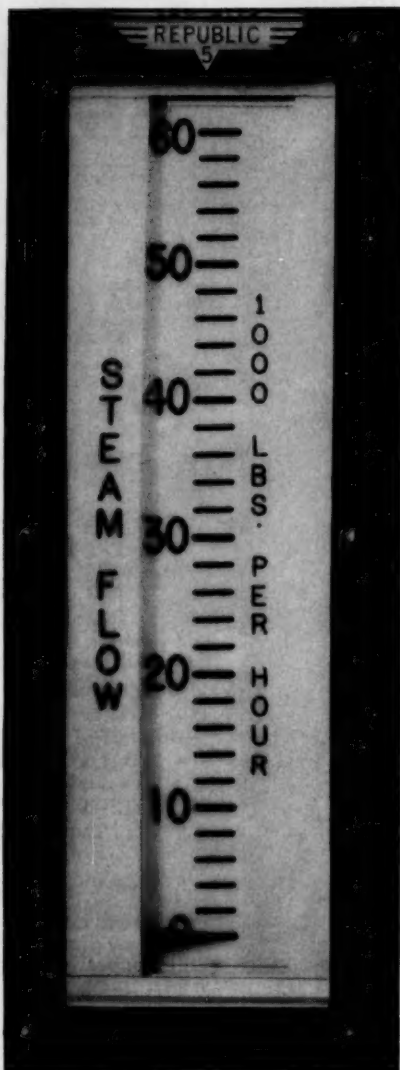
### BIG-GAUGE ACCURACY, TOO

Compact V-5 gauges are equipped with electric receivers or full sized diaphragms, bellows, and helixes for maximum accuracy and sensitivity. Yet these Rockwell-Republic gauges require one-fourth the panel space needed for standard gauges.

### GROUP MOUNTING INCREASES VERSATILITY

As many as eight gauges can be grouped in a single mounting case. Types can be mixed to meet individual panel requirements. Mounting is simple, too. Just a panel cutout is required in most cases.

There's a V-5 gauge for almost every process measurement. Mail the coupon today for the 12-page bulletin on these easy-to-read gauges, and for available literature on other Rockwell-Republic instruments, controls, and valves. RF-22



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| <input type="checkbox"/> Electronic Control Systems                 | <input type="checkbox"/> Pneumatic Control Systems |   |

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Company \_\_\_\_\_

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Republic Flow Meters Co. (Subsidiary of Rockwell Manufacturing Company)  
2240 Diversey Parkway, Chicago 47, Illinois

### BOOK SHELF . . .

analysis, and fuel cell applications in both mechanical and electrical power.

Well-written and systematic, the report is weakest when it attempts such predictions as how long it will be before fuel cells replace internal combustion engines. These predictions are based on "maybe's" and "if's"—one assumption, for example, is a "long-range" methanol production cost of 5¢/gal. (currently, costs run about 13¢/gal.).

As the authors themselves admit, much depends on the discovery and development of entirely new fuels, catalysts and ion-exchange membranes in record time. If their predictions are overly optimistic, however, the report has real flesh on its bones. It not only makes for intriguing reading, it also invites—almost insists on—the reader's own wild-eyed speculation.

### More New Books

*Progress in Powder Metallurgy. Vol. 16.* By various authors. Metal Powder Industries Federation, 60 East 42nd St., New York, N. Y. \$10.

*Experimental Plastics—a practical course for students.* By C. A. Redfarn and J. Bedford. Interscience. \$4.25.

*Hydrodynamics of Oceans and Atmospheres.* By Carl Eckart. Pergamon Press. \$9.

*International Mineral Processing Congress, 1960 (proceedings).* By various contributors. The Institution of Mining and Metallurgy, 44 Portland Place, London, W. 1. \$14.50.

*The Physico-Chemical Constants of Binary Systems in Concentrated Solutions. Vol. 4—Systems with inorganic + organic or inorganic compounds (excepting metallic derivatives).* By J. Timmermans. Interscience. \$39.

*Advances in Analytical Chemistry and Instrumentation. Vol. 1.* Ed. by C. N. Reilly. Interscience. \$12.

*The Encyclopedia of Spectroscopy.* Ed. by G. L. Clark. Reinhold. \$25.

*Official Methods of Analysis.* 9th ed. Ed. by W. Horwitz, et al. Assn. of Official Agricultural Chemists. Box 540. Benjamin Franklin Station, Washington 4, D. C. \$17.50 (single copy in U. S.).

*Pulp and Paper—chemistry and chemical technology.* 2nd ed, rev. Vol. 2: Papermaking. By J. P. Casey, Interscience. \$25.

*Introduction to Nuclear Science.* By A. Glassner. Van Nostrand. \$3.75.

# FILTER FABRIC QUIZ

## How would you solve these filter fabric problems?

### PROBLEM:

You're a soap manufacturer. You wish to filter foreign matter from oil and glycerin. What filter fabric would you use?

### SOLUTION:

Closely woven cotton duck has withstood six months of this arduous service. For even longer life, nylon fabrics are recommended.

### PROBLEM:

You're a dyestuffs manufacturer. You wish to separate a dye intermediate from a sulphuric and hydrochloric acid solution at 45°C. What filter fabric would you use?

### SOLUTION:

A spun dynel fabric with high chemical resistance is both dependable and durable for this highly corrosive process.

### PROBLEM:

You're a ceramics manufacturer. You wish to filter clay slurries. And the filter fabric must have good release characteristics and resist mildew and bacteria growth. What filter fabric would you use?

### SOLUTION:

A tough fabric of filament nylon is sleek enough that the filter cake drops away at the touch of a scraper—and so durable that fabric life is multiplied many times.

### PROBLEM:

You're a pigment processor. You wish to filter titanium dioxide from strong acid solutions with vacuum-type filters. What filter fabric would you use?

### SOLUTION:

A fabric of filament Dacron\*, highly resistant to mineral acids, provides smooth cake discharge and long service for maximum operating economy.

Each of these solutions is but one of many ways to solve these problems. For, as you know, countless factors help determine a filter fabric's performance—fiber, yarn, weave, count and finish, to name just a few. Selecting the most effective and economical filter fabric for a particular job is a very complex matter. And you need the assistance of

a specialist—like the specialists who distribute Wellington Sears fabrics. These distributors are experts in the field of industrial fabrics—and always ready to lend a hand in helping solve your problems. For their names, and a free copy of our illustrated booklet, "Filter Fabric Facts," write Dept. L-2 today.

\*DuPont trademark for its polyester fiber

## WELLINGTON SEARS

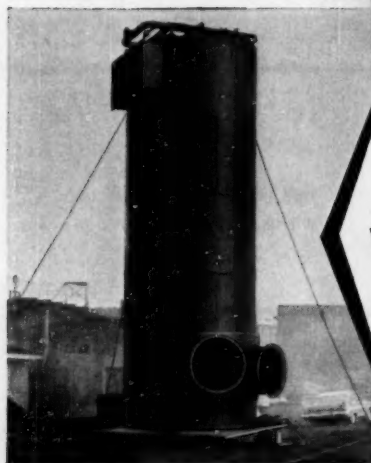
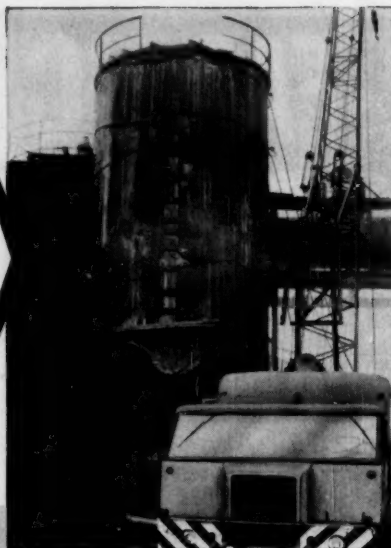


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WHEN  
CORROSION  
TAKES ITS  
TOLL



New duVerre Reinforced Resin Bonded Fiberglass scrubbing tower being installed at a large metal refining plant to replace the badly corroded steel unit shown in the upper photo.

REPLACE  
WITH  
CONSTRUCTION  
by  
*duVerre*

Where corrosion becomes prohibitively expensive—in high replacement costs, costly production downtime or contaminated product—it's time to investigate du Verre.

Tanks, ducts, hoods, stacks and other process equipment fabricated by du Verre of reinforced Resin Bonded Fiberglass, exhibit excellent resistance to both corrosion and erosion. They are many times lighter than steel, thus reducing freight, erection and supporting steel costs. du Verre has a smooth surface that improves flow characteristics and minimizes build-up of solids on interior surfaces.

Not a coating or lining, du Verre is a completely homogeneous reinforced lamination—uniformly corrosion-resistant inside and out. It can be fabricated to your special shape, size and process requirements.

Write today for Bulletin No. 101 and see how du Verre fabrications could be sparing you the high costs of corrosion.



First in Quality for  
Complete Corrosion Control  
with Reinforced Plastics

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#### BOOKSHELF . . .

*Characteristics of Engineers and Scientists.* By L. E. Danielson. Bureau of Industrial Relations. U. of Michigan. Ann Arbor, Mich. \$4.

*Manipulation of Thermoplastic Sheet, Rod & Tube.* By J. M. Estevez and D. C. Powell. Interscience. \$4.85.

*Ideas, Inertia and Achievement.* Prepared by F. B. Turck; edited by S. A. Tucker. The American Soc. of Mechanical Engineers, 29 West 39th St., New York 18, N. Y. \$5.

*Managerial Performance Standards.* By Virgil K. Rowland. American Management Assn., 1515 Broadway, New York 36, N. Y. \$5.25.

*Progress in Non-Destructive Testing.* Ed. by E. G. Stanford and J. H. Fearon. Vol. 2. Macmillan. \$12.

*Proceedings of the International Clean Air Conference—London, October 1959.* National Soc. for Clean Air, London. 30s.

*Wave Mechanics and Valency.* By J. W. Linnett. Wiley. \$3.

*The Sea Off Southern California—a modern habitat of petroleum.* By K. O. Emery. Wiley. \$12.50.

*Concepts of Space—the history of the theories of space in physics.* By M. Jammer. Harper Torchbooks. \$1.40.

*Readable Relativity.* By C. V. Durell. Harper Torchbooks. \$1.25.

*Physical Methods of Organic Chemistry—Part IV.* 3rd ed. Ed. by A. Weissberger. Interscience. \$26.

*An Introduction to the Study of Chemical Thermodynamics.* By D. H. Everett. Longmans, Green & Co. \$5.75.

*The Art of Persuasive Talking.* By L. Surlis and W. A. Stanbury, Jr. McGraw-Hill. \$4.95.

*Ultrasonics and Its Industrial Applications.* By O. I. Babikov. Consultants Bureau, New York. \$9.75.

*Fatty Acids—Part I.* 2nd ed., rev. Ed. by K. S. Markley. Interscience. \$22.50.

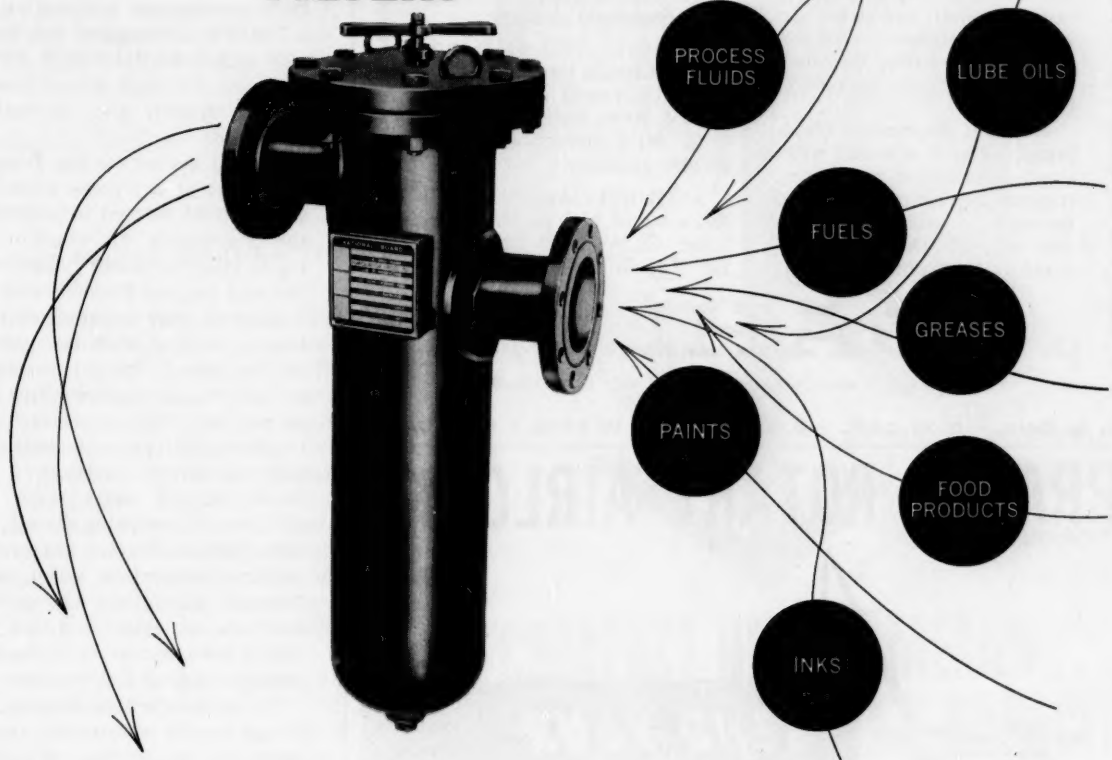
*Cobalt—chemistry, metallurgy and uses.* ACS Monograph 149. Ed. by R. S. Young. Reinhold. \$15.

*Space Biology—the human factors in space flight.* By J. S. Hanrahan and D. Bushnell. Basic Books. \$6.

*Zone Refining and Allied Techniques.* By N. L. Parr. George Newnes, Ltd., Tower House, Southampton St., Strand, London WC2. \$8.50.

*Mass Spectrometry—and its applications to organic chemistry.* By J. H. Beynon. Elsevier Publishing (Van Nostrand). \$24.

# LOOK WHAT THIS ONE PUROLATOR UNIT WILL FILTER!



**AND PRACTICALLY ANY OTHER FLUID OR SLURRY YOU CAN NAME!** The G-140 series will remove all impurities from 25 microns on up. Even highly corrosive fluids can be filtered with stainless steel models. Installation can be made on either the pressure or suction side of the pump.

**Continuous, permanent filtration.** Best of all, the G-140 series' filtering unit need never be replaced. Made of precisely-spaced metal ribbon wound into cylinder form, the filtering element will last the life of the filter.

**Cleans with a twist of a handle.** A twist of the handle on top of the unit cleans the filter. No need to disassemble the

unit or stop the flow of fluid. Turning the handle rotates filter unit against fixed knife blade which shears off waste—which is periodically removed through drain at the bottom. If service warrants, filter element can be rotated continuously by motor drive.

**Other specifications.** Degree of filtration: 25 to 500 microns. Element spacing: .001" to .020". Capacity: 6-200 GPM. Weight: 100 lbs. Operating temperature: up to 650°F. Operating pressure: 150 psi. Relief valve available on special order. ASME coded vessels also available.

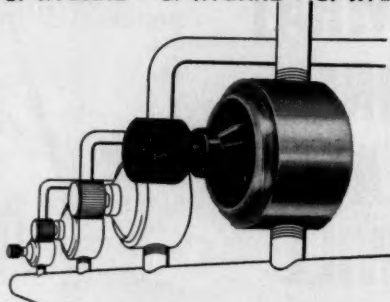
For full specifications and application information write: Purolator Products, Inc., Rahway, New Jersey.

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**PUROLATOR**  
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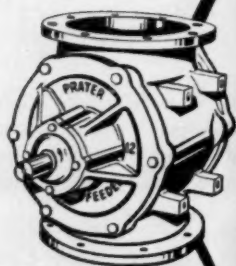
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## Letters: Pro & Con

### Pro: Teacher Guidance

Sir:

Having recently participated in a so-called Career Conference, I would like to offer some comments and observations on this method of communicating with young people about science and engineering.

Those who organized this particular conference did a good job, but obviously the high school teachers did not strongly urge the students to attend.

Having served on the Board of Education of my home school district, I have learned to understand the viewpoints of educators. I try to imagine myself in their position and ask how I would react were I asked to urge my students to attend a meeting with men whom I did not know, for the purpose of having them discuss problems within my own area of responsibility.

Although I am an amateur in the field of career guidance, I have found that I could serve most effectively by working directly with school administrators, teachers and guidance counselors, acting always through appropriate channels. It has been my experience that when this is done, educators in the school systems respond and cooperate.

In any conference meeting with young people, we see and speak to them all too briefly. We cannot establish full rapport with the students, and any advice offered must be limited and conditional.

On the other hand, the teachers in daily contact with the students are in a much better position to offer career guidance. All they need is a better understanding of science and engineering; this is most urgent in the case of non-science teachers.

As one way of helping achieve this objective, I am teaching a course, "Science in our Culture," as part of the in-service training program for non-science teachers and administrators in my local school district. This is to acquaint them with what science is and with what has been its impact on our lives

apart from its material contributions. I try to convey a little of my own enthusiasm for my profession, and we enter into many spirited discussions.

In this way, I reach 40 teachers, and through them over 1,000 pupils who receive continual impressions of science and its mission. These teachers will, moreover, be responsible for the instruction of many more pupils in years to come. If I were to attempt to reach these pupils individually, it would require far more time than I have to spend.

S. B. TUWINER

Consulting Engineer  
New York, N. Y.

### Foreign Business Headaches

Sir:

Our company has been manufacturing chemical, sugar and petroleum equipment for more than 70 years. Up until about five years ago, we enjoyed an export business amounting, at various times, to as much as 30% of our gross volume.

Recently we have encountered serious competition from Western European countries. Despite our customers' assurances that our prices and quality are competitive, we cannot extend suitable credit terms.

First of all, we must secure our payments in U.S. dollars. Most of our competitors abroad can take other currencies and, through various means, their particular government will exchange the various monies for its own currency. With our government proclaiming loud and long its desire to promote international trade, why doesn't it set up some form of barter or exchange bank whereby exporters like us can accept foreign currency and then obtain a fair exchange for U.S. dollars?

Secondly, in selling to a foreign customer we always run the risk of an internal revolution in which the new government confiscates the plant or refuses to allow payments to us on the equipment. In recent years, we have avoided this only by selling goods with an irrevocable letter of credit on an American

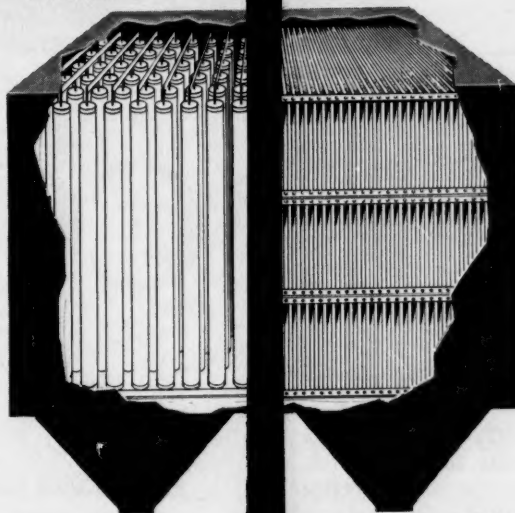
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"Roll-Clean" Dynaclone: Patents 2,867,289, 2,938,598. "Resist-O-Wear" Filter Bags: Patent 2,959,247.

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### PRO & CON . . .

bank, payable upon presentation of shipping documents. However, many sugar mills and other chemical processing plants in foreign countries cannot put together enough capital to buy major equipment in one lump-sum payment. They would like to purchase equipment on the installment plan, with payments spread over four or five years.

One difficulty with this is our lack of information on the credit reliability of foreign concerns. We wonder if there could not be set up an international kind of Dun & Bradstreet that could provide credit information on foreign customers.

Our government should also set up a form of insurance to protect American business firms against economic losses in case of a revolution. We understand the Western European countries have such insurance plans.

Some manufacturers have beaten the game by building their equipment at overseas plants. However, we believe this defeats the basic American idea of free enterprise—that we can and will build a better product here in the U.S. for less money if given the opportunity.

The above opinions are my own personal ones and are not to be construed as an expression of my employer's opinions or policy.

A. B. ADAMS

Goslin-Birmingham Mfg. Co.  
Birmingham, Ala.

### Tribute to Unsung Foremen

Sir:

It was certainly encouraging to read in your Jan. 9 issue (pp. 124-128) what I consider a nice tribute to the unsung operating foremen and supervisors who contribute a good share to the success of our chemical industries. The article by Mr. Richardson touches upon something most of us have experienced in taking processes from research to production. I want to second the motion on what he said.

The "can-do" ability Mr. Richardson emphasizes is a hard thing to measure. You can count patents or publications, but it is difficult to weigh many of the qualities which characterize the outstanding

operating man. He has an undefinable feel for equipment and processes which results in being able to keep his units running properly where others might not succeed.

J. E. TROYAN

Olin Mathieson Chemical Corp.  
Brandenburg, Ky.

► *This comment is especially significant in that it comes from the author of recent CE articles on plant startup (Sept. 5, 1960, pp. 107-127, and Nov. 14, 1960, pp. 223-226) and another one coming in our Mar. 20 issue.—ED.*

### Cross-Linking Catalyst

Sir:

In your "CPI Forecast for '61" (Jan. 9 issue) you have noted (p. 89) among the new technical developments in polyolefins that the "Lucidol Div. of Wallace & Tiernan brought out a substituted diperoxide catalyst for cross-linking high-density polyethylene to produce properties similar to those produced by irradiation."

The catalyst to which you refer is 2,5-bis(*tert*-butyperoxy)-2,5-dimethyl hexane. Use of this and similar peroxides for cross-linking polyethylene and other elastomers was discovered by Food Machinery & Chemical Corp. and is covered by U.S. patent 2,916,481, issued to E. R. Gilmont on Dec. 8, 1959, and assigned to FMC.

This peroxide has been distributed since early 1959 by R. T. Vanderbilt Co. under the trade-name Varox. Only during the past year has this material been offered by Lucidol under another trade-name.

E. R. GILMONT

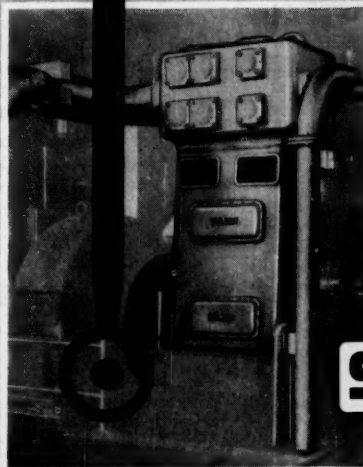
Food Machinery & Chemical Corp.  
Princeton, N. J.

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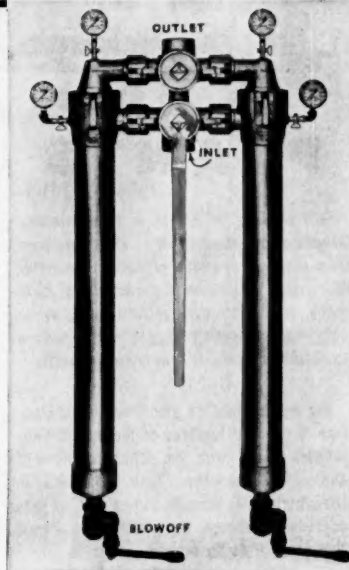
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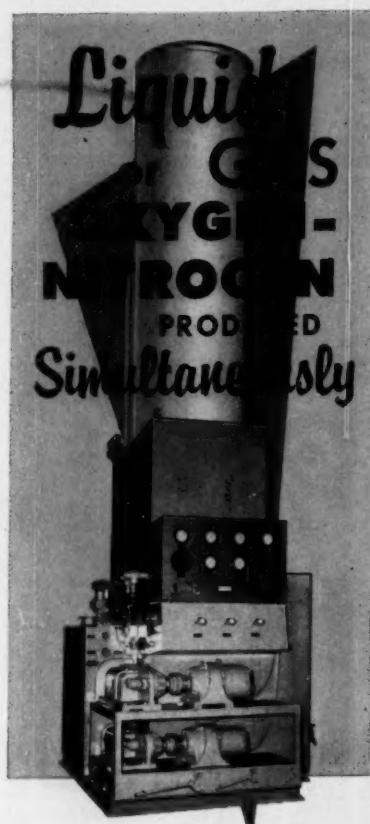
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### Contents of This Issue

Chemicals .....	226
Construction materials..	231
Electrical & mechanical.	232
Handling & packaging.	233
Heating & cooling.....	233
Instruments & controls..	235
Pipe, fittings, valves....	236
Process Equipment .....	238
Pumps, fans, compressors	240
Services & miscellaneous	242

### Chemicals

**Activated Carbon.....**A complete line of activated carbons for every purpose. Design and prefabricate complete purification, separation & recovery systems. Bul. J-103.  
L239 \*Barney-Cheney

**Adhesive.....**New adhesive for multi-wall polyethylene bags is now on the market. Used to spot-cement sheet to adjacent layers of kraft. Said to form strong bond. No. 1684.  
115-116f \*U. S. Industrial Chemicals Co.

**Alkaline Detergent.....**Leaflet describes cleaner designed to remove stubborn soils such as burned-on oil, heavy grease etc. that may be used on steel, brass magnesium etc.  
226A Oakite Products, Inc.

**Anti-Static Agent.....**CATANAC SN prevents dust-gathering static charges on plastic, paper, glass and a wide variety of substances. Further information is available.

8-9c \*American Cyanamid Company

**Butylene-Glycol.....**1, 3-butylene glycol offers longer chain length and molecular configuration plus many other advantages. Complete technical data is available.  
211 \*Celanese Chemical Co.

**Carbide Tools.....**Properties of steel-bonded carbide tools described in technical article that explains how this new powder metallurgy material forms a new class of cemented carbide.  
226B Sintercast Div.

**Chemicals.....**Information and samples are available on Sodium Borohydride in both powder and liquid form and on Lithium Aluminum tri-t-Butoxy Hydride, a new hydride.  
175 \*Metal Hydrides, Inc.

**Commercial Glasses.....**Booklet details properties of 32 commercial glasses; contains information on several new glasses as well as sections on thermal expansion and optical properties.  
226C Corning Glass Works

\* From advertisement, this issue

**Cyanogum Gel.....**Specific data are available to permit comparison of the CYANOGLUM system's permeability with that of other well known gels—viz agar, gelatin and silica.

8-9a \*American Cyanamid Company

**Desulfurization.....**Technical data bulletin describes desulfurization of coke oven BTX by sodium. Contains processes, results, economics, tables & illustrations. No. 1682.

115-116d \*U. S. Industrial Chemicals Co.

**Diatomite.....**Celite offers constant uniformity in every grade to assure constant results and less downtime. Many different grades of Celite are produced. Information.  
44 \*Johns-Manville

**Ethyl Alcohol.....**Copies of the Regulations Supplement and the Alcohol Catalog which have been reprinted by popular demand are available.

115-116b \*U. S. Industrial Chemicals Co.

**Filter Media.....**How better results in filtration can be achieved through scientific filter media selection is described in 8-page bulletin that contains case histories.  
226D The Elmco Corp.

**Gas Odorants.....**Types of odorizers, storage and transfer of odorants, control of nuisance odors, soil adsorption and methods of checking odor intensity covered in bulletin.  
226E California Chemical Co.

**Iron Powders.....**28-page brochure describes physical, chemical and electromagnetic characteristics. Bibliography outlines applications and provides reference sources.  
226F Antara Chemicals

**Latex.....**Intended as a guide for the industrial user of latex, booklet lists physical properties and suggested applications for a score or more of synthetic latices.  
226G Naugatuck Chemical Div.

**Light Absorber.....**Efficient on a variety of woods, CYASORB is added to the coating to retard wood discoloration from the effects of ultra-violet rays. Information.

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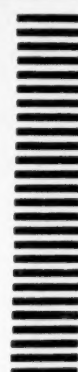
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4	25d	42	57	68	104A	112C	155	189	207A	216	224	231	235C	R241
6-7	25e	43	58	69	104B	112D	156a	190	208	217	T225	231A	T236	241A
8-9a	25f	44	59a	70	104C	113	157	191	208A	218a	B225	231B	B236	242
8-9b	26	45	59b	74	105A	114	159	194	209a	218b	226	231C	236A	242A
8-9c	27	46	59c	79	105B	115-116a	161	195	209b	218c	226A	T232	237	242B
8-9d	28	47	59d	80a	106A	115-116b	163	196	209c	218d	226B	B232	237A	242C
10-11	29	48	59e	81	106B	115-116c	165	197	209d	218e	226C	232A	237B	242D
12-13	30	49	59f	85	106C	115-116d	167	198	210	218f	226D	232B	L238	242E
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18-19a	33	51b	62	91	106F	115-116g	173	201	211	218i	226G	233A	238A	L251
18-19b	34-35	51c	63a	93	106G	115-116h	175	202	212	218j	T230	233B	238B	R251
18-19c	36	51d	63b	95	107	115-116i	177	203	212A	218k	B230	233C	L239	T252
18-19d	37	51e	63c	97	108A	115-116j	179	204	212B	219	230A	L234	R239	B252
20-21	39a	52	63d	99a	109	117	181	205	213	220	230B	R234	239A	253
22	39b	53	64	99b	110A	123	183	206	213A	221	230C	234A	L240	254
24	39c													

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78	79	80	81	82	83	85	86	87	88	89	90	91	92	94	95	96	97	98	99	100	101
102	103	105	107	108	109	110	111	112	113	114	115	117	118	119	120	121	122	123	124	125	126
127	128	129	130	131	133	135	136	138	139	141	142	143	144	145	146	147	148	149	150	151	152
153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174

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8-9c	27	46	59c	79	105B	115-116a	161	195	209b	218c	226A	T232	237	242B
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10-11	29	48	59e	81	106B	115-116c	165	197	209d	218e	226C	232A	237B	242D
12-13	30	49	59f	85	106C	115-116d	167	198	210	218f	226D	232B	L238	242E
14-15	31	50	60	87	106D	115-116e	169	199	210A	218g	226E	232C	TR238	L250
16-17	32	51a	61	89	106E	115-116f	171	200	210B	218h	226F	233	BR238	R250
18-19a	33	51b	62	91	106F	115-116g	173	201	211	218i	226G	233A	238A	L251
18-19b	34-35	51c	63a	93	106G	115-116h	175	202	212	218j	T230	233B	238B	R251
18-19c	36	51d	63b	95	107	115-116i	177	203	212A	218k	B230	233C	L239	T252
18-19d	37	51e	63c	97	108A	115-116j	179	204	212B	219	230A	L234	R239	B252
20-21	39a	52	63d	99a	109	117	181	205	213	220	230B	R234	239A	253
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102	103	105	107	108	109	110	111	112	113	114	115	117	118	119	120	121	122	123	124	125	126
127	128	129	130	131	133	135	136	138	139	141	142	143	144	145	146	147	148	149	150	151	152
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51a—PVC Ball Valves

51b—530 Gauge Protectors

51c—Flow Sheet

51d—"What's New"

51e—Catalog G-C 960

59a—Solenoid Starter

59b—Watertight Weatherproof Starter

59c—Corrosive Hazardous Gas Starter

59d—Combination Starter

59e—Hazardous Dust Locations Starter

59f—Corrosive Gas Locations Starter

209a—Ductile Iron Pumps

209b—Cryogen Pump

209c—Cotton Linter Pump

209d—Small Capacity Pump

218a—V-5 Gauges

218b—Computing Relays

218c—Flow Meters

218d—Pressure Reducing Systems

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### • Materials of Construction

Corrosion—Refresher on cause & cure (\$1).....	131
High-Temperature Materials—Inorganic, nonmetallic (75¢).....	120
High-Temperature Metals—Selection, directory (\$1).....	129
Lead Installations—Best designs for many uses (50¢).....	79
Nonmetallic Inorganics—For severe conditions (50¢).....	125
Plastic Pipe—How and when to use (75¢).....	135
Protective Linings—Choice, application, directory (\$1).....	88

### • Equipment and Design

Air Pollution—CPI plant solutions (50¢).....	143
Control Valves—Behavior and selection (75¢).....	141
Estimating Engineering Properties	
Thermal Conductivity.....	94
Viscosity (75¢).....	138
Critical Properties (75¢).....	149
Heat Capacities (75¢).....	109
Other Physical Properties	
Latent Heat (75¢).....	117
Surface Tension (75¢).....	126
Flowsheets—Engineering communiques (50¢).....	99
Flow File—50 design formulas (50¢).....	112
Flow Through Packing and Beds	
Packed Towers (50¢).....	103
Fixed and Moving Beds (50¢).....	107
Fluidized Systems (50¢).....	108
Heat Exchanger Design—Shortcut methods (75¢).....	52
Heat Exchanger Calculations—Use these charts (\$1).....	136
Instruments—"Hardware" section of Report 95 (50¢).....	96
Mechanical Seals—How to select and use (50¢).....	83
Packaging—Unit containers for chemicals (50¢).....	166
Piping—Roundup of process pipe, valves, fittings (75¢).....	40
Process Design: Fluid Flow—Size lines, pick pumps (\$1).....	161
Process Control—Instrumentation report (\$1).....	95
Pump Seals—Chemical plant practice (50¢).....	92
Water Conservation—Will taps run dry? (50¢).....	105
Water Pollution—Solve plant problems (50¢).....	122
Your Design Reference File	
Parts I-V (75¢).....	100
Parts VI-IX (75¢).....	110

### • Processes

Bio-oxidation—Treatment of wastes (50¢).....	68
Chemicals from Petroleum—Available processes (\$1).....	139
Extractive Metallurgy—By chemical processing (50¢).....	111
Ultra-Low Temperatures—Production and uses (50¢).....	133
Fermentation—Its chemical technology (50¢).....	74
High-Temperature Technology—Materials, processes (50¢).....	91
Manufactured Gas—To supplement natural gas (50¢).....	115
Moving Bed Processes—Theory plus application (75¢).....	64
Nuclear Industry—Role of chemical engineers (50¢).....	89
Nuclear Wastes—Treatment and disposal (50¢).....	150
Odor Control—How to be a good neighbor (50¢).....	98
Operation & Maintenance—The impact of trends (\$1).....	121
Photochemical Engineering—Uses, processes, reactors (75¢).....	59
Plants & Facilities—Inventory of 1959 (75¢).....	156
Processes & Technology—Eighth Inventory 1958 (50¢).....	118
Processes & Technology—Ninth Inventory 1959 (50¢).....	159

### • Costs and Commerce

Buyer-Seller Relations—Vendor's view (50¢).....	157
Capital Cost Estimating—Data, sources & methods (\$1).....	156
CE Cost File 1959—Quick estimating data (50¢).....	153

### • Cost and Commerce Cont.

Cost Control Systems—Reduce and control costs (50¢).....	102
Inflation—How to predict a shrinking dollar (50¢).....	78
Modernization—Tighten up for profits (75¢).....	128
Patent Fundamentals—Timely review (50¢).....	114
Petrochemicals—1958 economic review (50¢).....	123
Process Energy—Make or buy? (50¢).....	142
Professional Registration—For PE-Minded ChE's (50¢).....	85
Rockets and Missiles—Airborne reactor problems (75¢).....	119
60's Challenge Chemical Engineers (50¢).....	152

### • Unit Operations

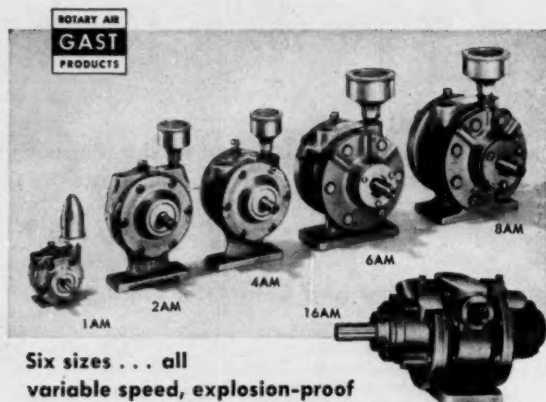
Absorption With Chemical Reaction—(50¢).....	162
Adsorption—Design, methods, materials (50¢).....	154
Azeotropic Separation—Close-boiler distillation (50¢).....	160
Binary Distillation—Theory, equipment (75¢).....	54
Compressible Fluids—How to handle (\$1).....	80
Crystallization—For purification (50¢).....	124
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Liquid-Gas Contacting—A practical operation study (75¢).....	82
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Lubrication—For chemical plant engineers (50¢).....	50
Plant Startups—Systematic preparation (50¢).....	165
Solids Concentration—Survey of techniques (50¢).....	67
Solids-Gas Contacting—Commercial practice (50¢).....	63
Solids-Liquid Separation—Unit operations description (\$1).....	62
Solid-Solid Blending—Theory, practice, equipment (75¢).....	163

### • Chemical Engineering Science

Analog & Digital Computers—In engineering use (50¢).....	145
Speculative Process Design—Pilot plant bypass (50¢).....	146
Pilot Plant—All the aspects of scale up (\$1).....	127
Statistics—How to use data effectively (75¢).....	73
CE Refresher	
Thermodynamic Principles (50¢).....	42
Compression & Expansion (50¢).....	45
Chemical Equilibrium (50¢).....	49
Homogeneous Kinetics (50¢).....	57
Catalytic Kinetics (50¢).....	61
Interpreting Kinetics (50¢).....	66
Simple Reactor Design (50¢).....	72
Complex Reactor Design (50¢).....	75
Catalytic Reactor Design (50¢).....	81
Reactor Design Problems (50¢).....	87
Physical Equilibrium I (50¢).....	90
Physical Equilibrium II (50¢).....	97
Fluid Flow Equations (50¢).....	101
Fundamental Math (75¢).....	113
Mass Transfer Operations (\$1).....	130
Unit Operations Refresher	
Fluid Flow (50¢).....	144
Sedimentation Theory (50¢).....	148
Heat Transfer (50¢).....	155
Unsteady State Heat Transfer (50¢).....	164
Absorption Methods—Unit operation refresher (50¢).....	168

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Absorption Methods—Unit operation refresher (50¢).....	168
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CE Cost File—Quick Estimates Data (75¢).....	172
CPI Forecast for '61 (50¢).....	170
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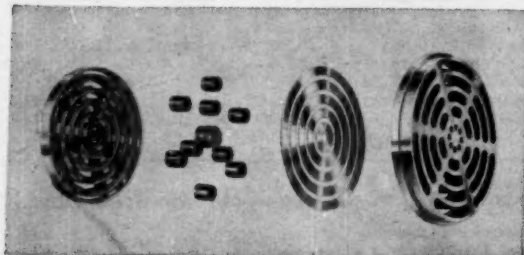
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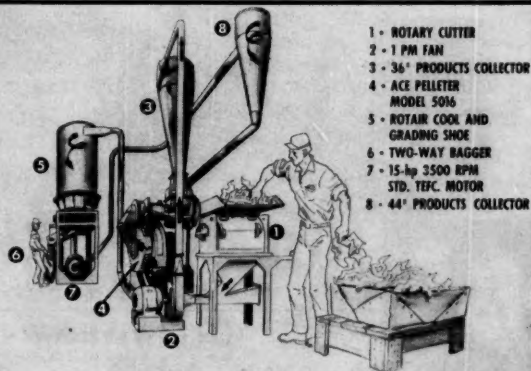


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167 \*American Smelting & Refining Co.

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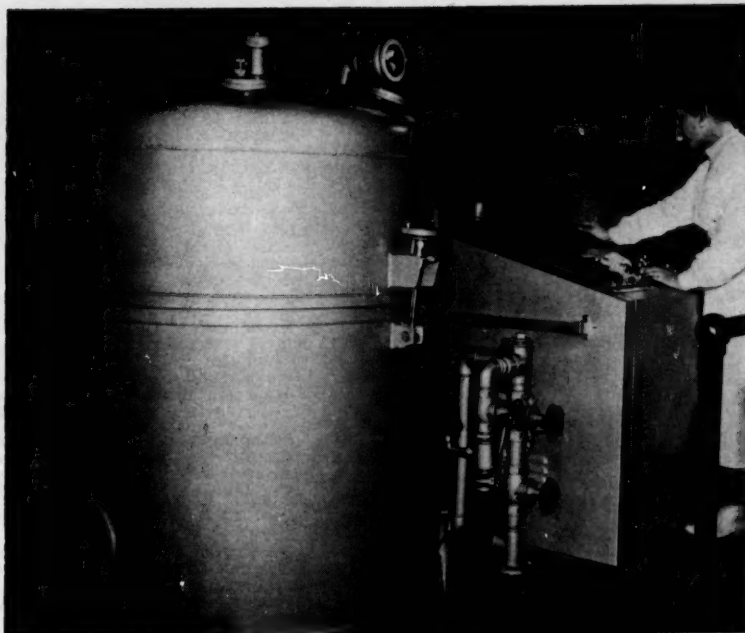
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188 \*Dynametrics Corp.

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213 \*Weighing & Controls, Inc.

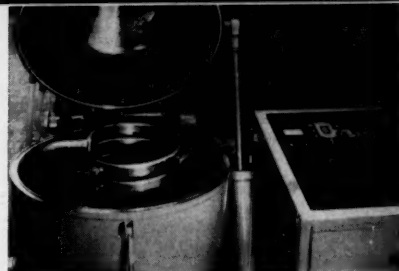
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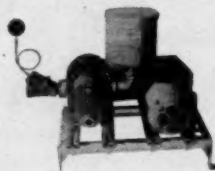
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234A Chicago Bridge & Iron Co.

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233 \*Consolidated Vacuum Corp.

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67 \*Bell & Gossett

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66 \*Platecoil Div., Tranter Mfg., Inc.

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TR238 \*Dean Products, Inc.

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126 \*Henry Vogt Machine Co.

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19,478

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BULLETIN  
V-837

**TABER  
PUMP CO.**

Est. 1859  
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BUFFALO 3, N. Y.



FIG.  
6043

**TABER**





## ERIEZ Magnetic Minute

60 seconds that will help you improve operating efficiency.



### Get UNWANTED IRON out of your product and flow lines

Can you be sure there's no fine ferrous contamination or tramp iron in your finished product or your flow lines?

You can if you install powerful Permanent Eriez Grate Magnets strategically. Now you can have foolproof magnetic protection where you've never been able to have it before.

- Choose from the most complete selection available . . . wing types, drawer types, multiple bank, rotary type, grates in housings, Rota-Grates in housings, and odd shaped assemblies — in 162 sizes.
- Performance is near perfect on a multitude of free-flowing bulk materials to 1/2 inch diameter. Special units available for liquid lines.
- Quickly and easily installed in steep-sloped hoppers, odd and regular shaped hoppers, floor openings, vertical closed chutes, ducts, etc.
- Erium® powered for more magnetic strength. Erium is our exclusive power source, designed to fit your application.

There's an Eriez Permanent Grate Magnet to solve your problems of ferrous contamination . . . yes, even problems which you may not know exist.

For big new bulletin, write to:

#### ERIEZ MANUFACTURING CO.

74PA Magnet Drive, Erie, Pa.



#### MAGNA-THOUGHT

"First cost is last cost". This is the policy we believe is best in the long run for our customers and ourselves.

*R.F. Merwin*

R. F. MERWIN  
President



A GROWTH COMPANY . . .  
10 NEW PRODUCTS IN THE LAST 5 YEARS

## LITERATURE . . .

**Vacuum Refrigeration . . . .** Chill-Vactor comes nearest to natural refrigeration. No chemical refrigerant or absorbent to leak, corrode or crystallize.  
200 \*Croll-Reynolds Co., Inc.

**Vaporizer . . . .** Vape-Sorber is used for aeration and agitation of liquids, air-cleaning of containers and protection of desiccants for dehydration. Booklet No. 82.  
T252 \*Selas Corp. of America

## Instruments & Controls

**Computer, Gas Flow . . . .** New gas flow computer eliminates accounting losses in custody transfer of gases. Measures, records and totalizes mass rate of gas flow.  
91 \*Minneapolis-Honeywell

**Control Systems . . . .** Provide maximum automation for data acquisition, transmission, recording and control of process variables. Technical Bulletin 10 available on request.  
41 \*Robertshaw-Fulton Controls Co.

**Controls, Temperature . . . .** Hold temperature as high as 3,000 deg. F. to within one degree or less, and follow set points with a repeatability of 0.1% full range.  
101 \*Hagan Chemicals & Controls, Inc.

**Dial Timer . . . .** Push-button automatic reset dial timer can control up to four individual load circuits. Bulletin gives data on application, construction, etc.  
235A Automatic Timing & Controls, Inc.

**Flowmeter System . . . .** Metering system comprised of a magnetic flowmeter and an indicator/recorder which measures fluids with conductivities as low as 0.1 micromhos.  
235B Fischer & Porter Co.

**Grate Magnet . . . .** Foolproof magnetic protection where you've never been able to have it before. A complete selection available. Details in big new bulletin.  
235C \*Eriez Manufacturing Co.

**Hygrometer . . . .** with the new hydrogen electrolytic cell for accurate measurement of moisture in hydrogen streams. Further helpful information in Data File 14-20-14.  
L250 \*Beckman Instruments, Inc.

**Meter, Magnetic . . . .** Bulletin 20-14 is available for complete details on Magnetic Meter for handling difficult liquids. Meter is completely corrosion proof.  
26 \*Foxboro Company

**Meters . . . .** Bulletin 566M is available on request and contains a variety of helpful data for your metering needs. Useful for both batching and accounting.  
46 \*Neptune Meter Company

**Meters . . . .** With this meter system there is no waiting for gauge tanks to fill, no bucketing, no errors, spillage or waste. Offer improved quality.  
111 \*Rockwell Mfg. Co.

**Pneumatic Controller . . . .** Series 624 A/D controllers offered for: pressure & vacuum ranges from full vacuum to 10,000 psi. & temp. ranges from 100°F. to + 1000°F.  
56 \*The Bristol Co.

\*From advertisement, this issue



## ERIEZ Magnetic Minute

60 seconds that will help you improve operating efficiency.



### FEED MOST ANYTHING, FROM OUNCES TO MANY TONS PER HOUR

There's an Eriez Vibratory Feeder to handle anything from powders to parts, rivets to rocks!

Versatile, AC operated Hi-Vi® Feeders, with 100% range of control, provide accurate, economical performance whether you're feeding a few ounces or many tons per hour. They're ideal for many feeding operations including spreading, sorting, aerating, cooling, drying, sifting, separating, proportioning, formulating, mixing, coating, and dusting.

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Choose from many models for light, medium, or heavy duty applications.

For big new catalog, write to:

#### ERIEZ MANUFACTURING CO.

74PB Magnet Drive, Erie, Pa.



#### MAGNA-THOUGHT

The selection of any piece of equipment should be based on its ability to perform effectively on the job.

*R.J. Torrey*

R. J. TORREY  
Manager  
Research & Development



A GROWTH COMPANY . . .  
10 NEW PRODUCTS IN THE LAST 5 YEARS

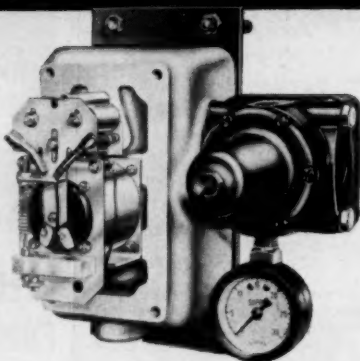


## SPEED INPUT SIGNAL TO CONTROL VALVE

with FISHER Type 543 Electro-Pneumatic Transducer

Available with  
or without a  
pneumatic valve  
positioner

Developed for use in electrical control loops where final control element is pneumatically operated. Explosion proof... ideal for use in hazardous conditions. Built in volume relay permits direct operation of actuator from transducer. No extra relays or boosters needed.



Input signals from 1 to 5 ma...  
output from 3 to 15 psi  
through 6 to 30 psi.

**FISHER GOVERNOR CO.**

Marshalltown, Iowa / Woodstock, Ontario  
London, England

BUTTERFLY VALVE DIV., CONTINENTAL  
EQUIPMENT CO., CORAOPOLIS, PENN.



## CUT EQUIPMENT MAINTENANCE COSTS...

with Clean-Dry  
Compressed Air!

ADAMS AFTERCOOLERS provide virtually complete condensation of equipment damaging oil, moisture and dirt from pipeline gases — by efficient cooling to within 2°F. of the cooling water. ADAMS CYCLONE SEPARATORS then remove this condensate at a constant high-efficiency separation factor over all load ranges.

Adams offers this outstanding performance at substantial savings, made possible through specialization in Aftercoolers and Cyclone Separators — plus quality manufacturing methods developed over the years.

Investigate this low-cost method of protecting your pneumatic equipment, instruments and controls — write today for Bulletin 714! R. P. Adams Co., Inc. 207 East Park Drive, Buffalo 17, New York.



**ADAMS** QUALITY COMES THROUGH

### LITERATURE . . .

**Pulsation Snubbers**.....are the most effective control measures available to eliminate pulse-induced vibration. Equipment performs better and operating costs are reduced. 237 \*Burgess-Manning Company

**Recorder - Controller**.....employing fluorescence techniques is claimed to combine operating simplicity with high sensitivity. No. 1689. 115-116j

\*U. S. Industrial Chemicals Co.

**Recorders**.....The tremendous power of the 90J (pneumatic) and the 700J (electronic) recorders gives you greater accuracy than ever before. Bulletins 98286 and 98335. 114 \*Taylor Instrument Companies

**Simulator**.....New Unite Operations simulator for the 1620 data processing system is now available. Consists of 13 automatically available sub-routines. 157 \*International Business Machines

**Slide Rules & Calculators**.....Seven slide rules & calculators designed for chemists are described in literature now available on request. No. 1681. 115-116c

\*U. S. Industrial Chemicals Co.

**Thermostats**.....Circulating thermostats are available which can be used for either heating or cooling. For control of liquid temperatures or for circulation of liquids. 1685. 115-116g

\*U. S. Industrial Chemicals Co.

**Transducer**.....Type 543 Electro-Pneumatic transducer is available with or without a pneumatic valve positioner. Input signals from 1 to 5 ma. T236

\*Fisher Governor Co.

### Pipe, Fittings, Valves

**Air Control Valves**.....Digest catalog covers full line of 2, 3, 4 Way and 4 Way 5 Port poppet valves. Air and solenoid pilot operators are coordinated in chart. 236A

Hoffman Valves, Inc.

**Ball Valve**.....Flo-Ball features top entry, in-line maintenance, top and bottom guided ball, double seats, flanges integral with body, block and bleed, etc. Details. 6-7

\*Hydromatics, Inc.

**Fittings**.....A complete line of Parkerized Fittings in sizes 1/8" to 4" resist corrosion on shelf or in high-pressure steam, water, oil, gas & air applications. 16-17

\*Clayton Mark & Co.

**Heat Exchanger Tube**.....Titanium heat exchanger tube with .049 wall thickness and less can successfully handle products such as acetic acid, nitric acid and chlorine. 37

\*Wolverine Tube Div. of Calumet Hecla

**Pipe**.....Bondstrand plastic pipe is made of tension-wound glass filaments impregnated with resin. Information is available in bulletin on physical & design data. 183

\*Amercoat Corp.

**Pipe**.....Saran Lined Pipe, fittings, valves and pumps are available for systems operating from vacuum to 300 psi, from below zero to 200 F. Information. 50

\*Saran Lined Pipe Co.

\*From advertisement, this issue

**Pipe, Epoxy.....** offers ease of handling, lightweight, dielectric properties and structural stability. Handles temperature & pressure problems efficiently. Information.  
43 \*Fibercast Company

**Pipe, Glass.....** Kimax glass pipe is indifferent to the attack of most acids and alkalis and is economical in both installation and maintenance. Information.  
113 \*Kimble Glass Div. of Owens-Illinois

**Pipe, Pyrex.....** Complete information about Pyrex Pipe as well as a complete line of Pyrex brand heat exchangers and laboratory drain-lines & fittings.  
201 \*Corning Glass Works.

**Pipe, Rubber.....** Condor flexible rubber pipe outlasts steel 3 to 10 times. Installation is easy, economical and there is no danger of leaky joints at pipe bends. Bul. 7152.  
40 \*Raybestos-Manhattan, Inc.

**Rotary Joints.....** Joints that require no lubrication, work equally well for single flow or syphon steam service, and handle steam and virtually any fluid. Catalog.  
237A Barco Manufacturing Co.

**Sizing Chart.....** 4-page chart bulletin JSC-1 shows how to size companies sliding gate regulators and control valves—covers steam, liquid and gas service.  
237B OPW-Jordan Corp.

**Spray Nozzles.....** A complete selection of automatic pneumatic atomizing nozzles. Catalog 24 describes Adjustable Joints and Bulletin 93 for Split-Eyelet Connectors.  
T232 \*Spraying Systems Co.

**Swivel Joints.....** "Facts You Should Know About Swivel Joints" contains a wealth of useful information on the application of swivel joints in line design.  
155 \*Chiksan Company

**Tube, Heat Exchanger.....** for applications from marine to petrochemical, from compressor intercoolers to "cat-cracker" exchangers in many popular alloys.  
189 \*Scovill Manufacturing Co.

**Valve, Diaphragm.....** Packless diaphragm valve is ideal for instrument air and other gas and liquid services. Data on this low cost, high performance valve is offered.  
222 \*G. W. Dahl Co., Inc.

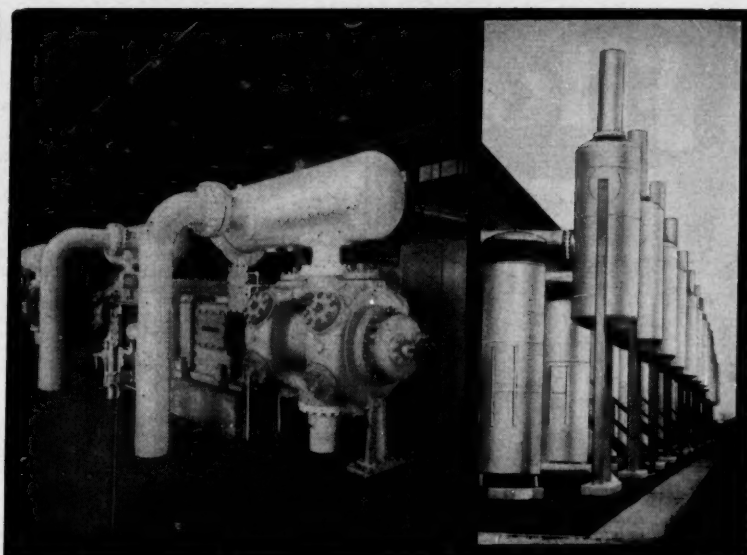
**Valve, Diaphragm.....** is available in a range of motor sizes from 1/2" through 6" valves. Wide choice of accessories such as: handwheel closing device, positioner, etc.  
70 \*Grinnell Company

**Valves.....** These valves are made to specification, machined from solid stock (not cast) using best alloy steels. Plates are machined (not stamped) for close tolerance fit.  
B230 \*J. H. H. Voss Co., Inc.

**Valves, Ball.....** For service up to 600 psi., 4 models available. Sizes 3/4" through 2" to handle air, alcohols, fuel and inert gases, water glass and many other fluids.  
57 \*Rockwood Sprinkler Company

**Valves, Ball.....** are available in carbon steel to ASA 300 lbs. (some sizes 600 lbs.), and in semi-steel, ASA 200 and 400 lbs. WOG. Catalog 1000 for further information.  
65 \*W-K-M Div. of ACF Industries

\* From advertisement, this issue



## ELIMINATE PULSATION AND NOISE WITH BURGESS-MANNING SNUBBERS

Burgess-Manning Pulsation Snubbers are the most effective control measures available to eliminate pulse-induced vibration. Equipment performs better, operating and maintenance costs are reduced, breakdowns and repairs are fewer, and even structural damage to buildings and foundations is prevented. Similarly, when a Burgess-Manning Silencer is installed to eliminate excessive noise, employees work more efficiently, with fewer accidents and errors, production is usually increased, and a plant's labor and community relations are improved. ■ If noise or vibration from the intake or discharge of internal combustion engines, blowers, turbines, compressors, gas or steam vent valves, pressure regulators, and similar equipment is a problem with you, contact Burgess-Manning. Nowhere in the world will you find a company better qualified, with more experience, a better engineering background, and a wider range of products for noise and pulsation attenuation. *Pictured: Burgess-Manning Pulsation Snubbers, Filter-Silencers, and Exhaust Silencers on gas-driven compressors in petroleum pipe line station.*

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**Industrial Silencer Division  
BURGESS-MANNING COMPANY**

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# Fike

Custom  
Quality Engineered  
**RUPTURE DISCS**  
to meet  
Your Requirements

Fike Model CPV Disc



## DESIGNED FOR LOW PRESSURE APPLICATION

The Fike CPV unit is more rugged than conventional rupture discs of low rupture pressure. It is more easily handled and there is less danger of damaging the rupture disc during installation. The close fitting hold-down ring holds the rupture disc snugly to the vacuum support. This reduces wrinkling and possible fatigue failure in cycling vacuum and pressure service. Sizes 1" to 30".

Fike Model HOV Disc



## DESIGNED TO OPERATE CLOSER TO RUPTURE PRESSURE

The Fike HOV disc is recommended for operating pressures up to 75% of rupture pressure at any service temperature. Conventional discs are not recommended to operate higher than 70% at ambient temperature or less as temperature increases. Rugged design makes these low pressure discs easier to handle and install. Sizes 1" to 30".

Send for the new complete catalog  
on Fike Rupture Discs.

**Fike**  
METAL PRODUCTS CORP.  
Dept. CE  
Blue Springs, Missouri

## LITERATURE . . .

**Valves, Gate.** . . . Aluminum gate valves are available in sizes from ½" through 24". Feature accurate casting control and precision assembly to reduce friction.  
212 \*Darling Valve & Mfg. Co.

**Valves, Plug.** . . . Jacketed plug valves can be supplied for air or hydraulic operation. Complete description, details & dimensions in new catalog supplement 356-S.  
R250 \*Parks-Cramer Co.

## Process Equipment

**Aftercoolers & Separators.** . . . Information concerning the low-cost method of protecting your pneumatic equipment, instruments & controls in Bulletin 714.  
B236 \*R. P. Adams Co., Inc.

**Crushers.** . . . Complete information about the 60" gyratory crushers and other Traylor crushers made for primary, secondary or fine reductions in Bulletin No. 1126.  
28 \*Traylor Engineering & Mfg.

**Crystallizers.** . . . New Draft Tube Baffle crystallizers are the most advanced yet designed for production of large, uniform crystals. Details in Bul. SW-206.  
206 \*Swenson Evaporator Co.

**Crystallizers.** . . . Three types of DTB crystallizers are available. Information is offered to help determine the one best suited to your needs. Send for your copy.  
207 \*Swenson Evaporator Co.

**Deionization System.** . . . Whatever your specifications, the equipment comes completely packaged ready to deliver pure water instantly. Nothing to assembly.  
TR240 \*Penfield Mfg. Co., Inc.

**Dissolvers & Mills.** . . . produce more, in less space, at less cost and produce it better. Dissolvers pre-mix material for milling and mills finish off products. Information.  
24 \*Morehouse-Cowles, Inc.

**Drum Separators.** . . . Brochure describes line of wet permanent magnet drum separators available in both concurrent and counter-rotation styles in a variety of sizes.  
238A Stearns Magnetic Products

**Dust Arresters.** . . . Automatic dust arresters operate continuously without even momentary loss of efficiency. Complete information on any type problem is offered.  
68 \*Buell Engineering Co., Inc.

**Dust Filter.** . . . AC Reverse Jet dust filter offers super-capacity to give you more for your money. Handles 10 to 280 cu. ft. of air per sq. ft. of filter cloth. Bul. F-75.  
159 \*The Day Company

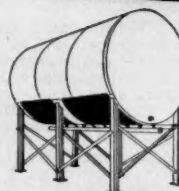
**Dust Filters.** . . . The Dynaclone operates continuously & provides 20 to 40% more cloth. Automatically self-cleaning by reverse air. The 36-page Catalog 104 offered.  
223 \*The W. W. Sly Mfg. Co.

**Feeder.** . . . Vibratory feeders to handle anything from powders to parts, rivets to rocks. Choose from many models for light, medium or heavy duty application. Catalog.  
238B \*Eriez Manufacturing Co.

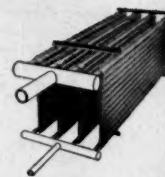
\* From advertisement, this issue

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**DEAN**  
**PANELCOIL**  
FOR HEATING-COOLING



Panelcoil applied to  
underside of storage  
tank.



Bank of Panelcoil  
for high capacity  
heat transfer.

Thousands of installations prove Panelcoil more versatile, more adaptable, easier to apply, more efficient than other means of heat transfer in or on tanks, vessels, chambers or cabinets; as banks, platens, shelves, troughs, hoppers, ducts, etc.

The new Dean Panelcoil Data Book gives helpful, practical facts and technical data on heating and cooling. Write for a copy.



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1039 Dean St., Brooklyn 38, N. Y.  
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# POSEY WORKS FOR BETTER-

## PRECISION MIXING

Lancaster Counter-Current Rapid Batch Mixers provide balanced mixing and mulling action for uniform precision mixing of any pre-sized solids with or without liquid additives.

Write for **FREE** illustrated brochure with specifications on all models and sizes.



Custom Fabrication  
For Over 50 Years

**DIVISIONS:**  
• Iroquois Asphalt Plants • Mixers and Blenders  
• Tunnel Forms • Industrial Heating • Foundry  
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557 S. PRINCE STREET

LANCASTER, PA.



## how to bar the tar



A vapor trap no bigger than a cigarette filter—now, oddly enough, goes on a cigarette that's making big news. Vapor phase contaminants such as tars are hauled up short by activated charcoal built into the filter. Maybe you are a pipe smoker—or a non-smoker—and worry about contaminants in other forms. Try activated charcoal. It'll knock the tar out of your problems.

## how to make dew



Do you make do with water laden with chlorine and organic decay or discoloration when fresh morning dew will do better? Make dew do for you too with water purified by activated charcoal. Chemical, pharmaceutical and food producers have been doing it for years. It's a sure bet for product improvement.

## activated carbon



We supply a complete line of activated carbons for every purpose; design and prefabricate complete purification, separation, and recovery systems to meet your particular needs. Write for Bulletin J-103 and recommendations on your specific application. Barnebey-Cheney, Columbus 19, Ohio.

# Barnebey Cheney

### LITERATURE . . .

**Filter Press**.....can be equipped with any type of plates—made of virtually any material—to handle any filterable mixtures—and most filter media. Sperry Catalog offered. 61 \*D. R. Sperry & Co.

**Filters**.....Duo double duty fluid filter is sealed at each end to eliminate trepassing. In bronze, steel, 316 stainless steel & aluminum. Full data is offered. B225 \*Ronningen-Petter Co.

**Industrial Silencers**....Condensed design manual discusses methods of handling noise problems generated by gas flow devices. Acoustic criteria to be met are discussed. 239A Silense Inc.

**Hydraulic Systems**.....Information on the job being done by packaged hydraulic systems in the processing industries is contained in Bulletin I5802. 169 \*Vickers, Inc.

**Inert Gas Generators**.....stand up under the toughest conditions, yet produce with complete dependability. Complete information in Bulletin I-10. 177 \*The C. M. Kemp Mfg. Co.

**Micronizers**.....grind and classify in one operation in a single chamber. Provide fines in range from  $\frac{1}{2}$  to 44 microns. Eight models available featuring no attrition heat. L241 \*Sturtevant Mill Co.

**Mills**.....Vibro-Energy Mill vibrates at high frequency and wet grind particles to .000039-inch. Produces fine particles faster & more economically. Tech paper. 93 \*Southwestern Engineering Co.

**Mills, Colloid**....for dispersing, emulsifying, disintegrating and homogenizing. Used where fineness and uniformity of grind are needed. Information is available. B252 \*Premier Mill Corp.

**Mixers**.....Dependable mixing is assured to give you more profit in your process. Used for agitating, mixing, reacting, suspending solids & other applications. Bul. 581. 163 \*Nettco Corp.

**Mixers**.....Bulletin LL-60 contains full information on how these lifting-lowering mixers can improve the effectiveness of your mixing operations. 58 \*Philadelphia Gear Corp.

**Mixers**.....Illustrated brochure with specifications on all models & sizes of Lancaster Counter-Current Rapid Batch Mixers for uniform precision mixing. BR238 \*Posey Iron Works, Inc.

**Mixers, Pony**.....A model for every need with single motion or twin motion mixing action, 1 or 2 speed motors, in working capacities from 3 to 125 gal. Bul. 500. 195 \*The J. H. Day Co.

**Mulling**.....Simpson Mix-Muller is specifically designed to put you in control of mixed properties. The Handbook on Mulling is available on request. 123 \*National Engineering Co.

**Process Equipment**.....Votator processing equipment is used for continuous polymerization reactions in numerous installations. Votator pilot systems available. Details. 109 \*Girdler Process Equip. Div.

\*From advertisement, this issue

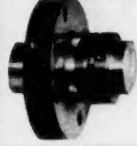
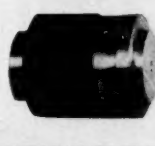
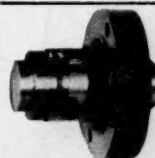
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## means VERSATILITY in mechanical sealing

Dura Seal is the most extensive line of mechanical seals offered to industry today . . . meeting a wider range of pressures, temperatures and liquids.

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KALAMAZOO, MICHIGAN



# The FALCON RIBBON BLENDER

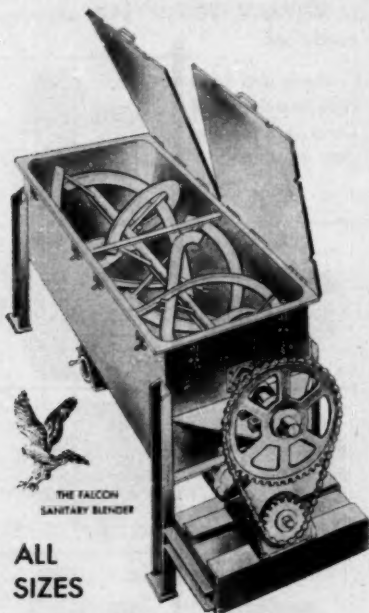
"the TOP-FLIGHT Mixer"

- POWER
- PRODUCTION
- PRICE

## FEATURES . . .

- All Welded Construction
- Mild Steel or Stainless
- Approved Sanitary Design
- All Rounded Corners Thruout
- Quickly Demounted for Cleaning
- Extra Heavy Shafts and Ribbons
- Leak Proof-Dust Tight Outlet
- All Sizes Usually in Stock

MANY REPEAT ORDERS FROM PLANTS  
NOW USING FALCON MIXERS



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THE FALCON  
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DIVISION

OF THE  
FIRST MACHINERY CORP.

209-289 TENTH STREET,  
BROOKLYN 15, N. Y.  
PHONE: STerling 8-4672

## LITERATURE . . .

**Process Equipment**.....Pressure vessels and heat exchangers of any type built. Scientists and engineers available for analysis and recommendations. Information.  
81 \*A. O. Smith Corp.

**Processing System**.....A compact, integrated system for producing agglomerates suitable for use by compounders or molders. Bulletins & technical assistance available.  
231 \*Sprout, Waldron & Co., Inc.

**Purifiers**.....Hi-eF purifiers can be relied upon to give outstanding performance. Bulletin 804 contains specifications on standard type plus engineered units.  
B232 \*The V. D. Anderson Company

**RDC Column**.....combines many advantages such as high volumetric efficiency, high throughput capacity, elimination of interstage settling, etc. Bul. #T-1159.  
191 \*Gen. American Transportation

**Ribbon Blender**.....features all welded construction, extra heavy shafts and ribbons and approved sanitary design. Quickly demounted for cleaning. Brochure.  
L240 \*Falcon Mfg. Div. of First Mach.

**Vacuum Drying**.....Drying systems in capacities from a few lbs. to several tons available...along with application engineering, laboratory service & pilot plant operations.  
14-15 \*F. J. Stokes Corp.

## Pumps, Fans & Compressors

**Chemical Liquid Pumps**.....These specially designed pumps stand up under the severest service. Choose from numerous models in exactly the trim you need. Bulletin 976.  
25d \*Buffalo Forge Company

**Clear Water Pumps**.....For peak efficiency in clear water service. Highest quality construction assures long maintenance-free life. Further details in Bulletin 955.  
25a \*Buffalo Forge Company

**Close-Coupled Pumps**.....Save space without sacrificing efficiency. Installation is simplified, no need for shaft alignment. Bulletin 975 is available on request.  
25f \*Buffalo Forge Company

**Compressor, Piston**....Non-lubricated ringless piston compressor assures absolute contamination-free compression of dry or moist gases. Information, specifications.  
T225 \*Sulzer Bros. Inc.

**Compressor Systems**.....Bulletin 189 describes high pressure packaged compressor systems for military, commercial, laboratory and pilot plant use.  
240A Clark Bros. Co.

**Compressors, Centrifugal**....Model G single-stage compressors are available in 6 models with capacities from 500 to 15,000 cfm. at 3 to 20 psig. on air service. Bul.  
31 \*Joy Mfg. Co.

**Fan**.....New design duct fan by De Bothezat has a removable cone design. Descriptive literature on this new type is available on request. Send for your copy.

198 \*American Machine & Metals, Inc.

\*From advertisement, this issue

Deionization by  means:

# INSTANT HIGH PURITY WATER

Need 50 gph flows of 18-22 megohm water at multiple points of use? Or is your need 10,000 gph of centrally filtered and demineralized process water? Want automatic shut-off at pre-selected purity? And automatic regeneration, including rinsing and recutting in; at the turn of a single switch?

Whatever your specifications, when the deionization system is by Penfield your equipment arrives at the site completely "packaged" — ready to deliver the pure water you need *instantly*. There's nothing to assemble, no need even to test-run.\* You just connect to existing plant lines and start-up.

Penfield service, too, deserves its "instant" reputation. 15 years of ion exchange pioneering means that Penfield has on file *field-proved* answers to most industrial water problems — usually can detail the system you need by phone, ship your completely "packaged" units in a matter of days.

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\*Resin charges are pre-rinsed and each Penfield unit test-run before shipment.



Manufacturing Co., Inc.

Telephone: BEverly 5-1894

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Industrial Ion Exchange Systems • Filters  
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methods, data, principles . . .

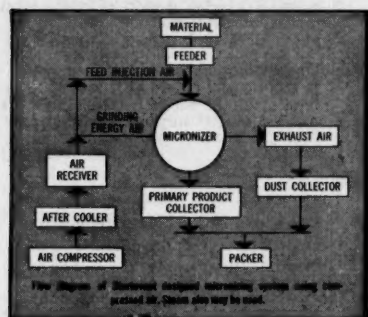
# COST ENGINEERING IN THE PROCESS INDUSTRIES

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## Need 1/2 to 44 Microns?

### Sturtevant Micronizers\* Make 325 Mesh Obsolete



#### One Operation Reduces, Classifies

Sturtevant Micronizers grind and classify in one operation in a single chamber—provide fines in range from 1/2 to 44 microns to meet today's increased product fineness needs. Can handle heat-sensitive materials.

Production Model  
(15 in. chamber)

#### No Attritional Heat

Particles in high speed rotation, propelled by compressed air entering shallow chamber at angles to periphery, grind each other by violent impact. Design gives instant accessibility, easy cleaning. No moving parts.

#### Classifying is Simultaneous

Centrifugal force keeps oversize material in grinding zone, cyclone action in central section of chamber classifies and collects fines for bagging. Rate of feed and pressure control particle size.

#### Eight Models Available

Grinding chambers range from 2 in. diameter laboratory size (1/2 to 1 lb. per hr. capacity) to large 36 in. diameter production size (500 to 4000 lbs. per hr. capacity). For full description, request Bulletin No. 091.

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A 30 in. Sturtevant Micronizer is reducing titanium dioxide to under 1 micron at feed rate of 2250 lbs. per hr. For another firm, a 24 in. model grinds 50% DDT to 3.5 average microns at a solid feed rate of 1200-1400 lbs. per hr. A pharmaceutical house uses an 8 in. model to produce procaine-penicillin fines in the 5 to 20 micron range. Iron oxide pigment is being reduced by a 30 in. Micronizer to 2 to 3 average microns.

Sturtevant will help you plan a Fluid-Jet system for your ultra-fine grinding and classifying requirements. Write today.

#### Can Test or Contract Micronizing Help You?

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## LITERATURE . . .

**Fan, Centrifugal.** . . . The new airfoil centrifugal fan uses less than half the installed space of conventional centrifugal fans. Catalog is available on request.  
53 \*Westinghouse, Sturtevant Div.

**Heat Transfer Pumps.** . . . Specially designed to handle high temperature liquids. High efficiency single suction, solid shell design. Information is available.  
25c \*Buffalo Forge Company

**High Pressure Pumps.** . . . Designed for boiler feed and other clear water installations. Assure peak efficiency, minimum downtime and long life. Bulletin 980.  
25c \*Buffalo Forge Company

**Metering Pump.** . . . Pulsafeeder metering pump offers precision metering at flow rates of from a few drops to 15.7 gal. per minute. Complete details in Catalog 59.  
49 \*Lapp Insulator Co.

**Non-Clogging Pumps.** . . . Efficiently move high consistency liquids. Rubber-lined models for moving abrasive & corrosive liquids. Bulletin 953.  
25b \*Buffalo Forge Company

**Pump.** . . . New Series G Chempump all but does away with bearing maintenance. Features have been field-proved in over 100 installations. Bulletin 2050.  
124 \*Chempump Div. Fostoria Corp.

**Pump.** . . . Bulletin describes new medium range centerline mount pump capable of handling virtually all liquids in refining and petrochemical manufacture.  
241A Peerless Pump

**Pump.** . . . New positive displacement handles without turbulence, pulsation, aeration or agitation, corrosive-problem liquids of high or low viscosity. Catalog P 302.  
205 \*Waukesha Foundry Co.

**Pumps.** . . . for hard-to-handle liquids in the chemical industry. Pumps range from 25 to 2500 hp., pressures to 50,000 psi. Additional information is available.  
190 \*Aldrich Pump Company

**Pumps.** . . . Parts are standardized and readily interchangeable. Plant expansion is economical because of their adaptability. Complete descriptive lit. available.  
107 \*The Deming Co.

**Pumps.** . . . Durcopumps are available in fourteen alloys and special materials. Heads to 345 feet, capacities to 3500 gpm. Further information in Bul. P-4-100.  
181 \*The Duriron Co., Inc.

**Pumps.** . . . Used to handle liquid chlorine these pumps prevent contamination of the liquid or corrosion of the equipment. Complete summary of data in Bulletin 203-8.  
202 \*Lawrence Pumps, Inc.

**Pumps.** . . . Type DL and DM pumps are of integrated design and efficiently pump virtually all liquids used in the process industries. Bulletin B-1608 is offered.  
10-11 \*Peerless Pump

**Pumps, Acid.** . . . with rugged, simple frame construction & packingless design. Long wear parts, few in number, are available in a variety of metal alloys as well as plastic.  
253 \*A. R. Wilfey & Sons, Inc.

\*From advertisement, this issue

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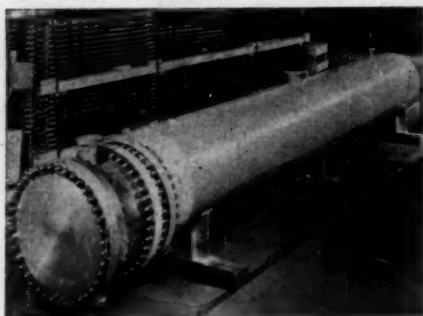


Vital chemical processes, today, require the utmost in ingenious, reliable equipment.

Typical of Vilter's contribution to America's strength and progress is the heat exchanger shown—an original Vilter design.

Custom designed to aid the production of solid boron fuel, this vessel is fabricated entirely of stainless steel. Separate condenser and receiver sections have been assembled into a single unit, ASME coded to  $-70^{\circ}\text{F.}$ , with propane used as refrigerant. Vilter designed, built and installed this unit to exacting design requirements.

Another example of the specialized vessels and heat exchangers Vilter designs and builds is the lean glycol amine solution cooler shown below. This kettle type, flooded Refrigerant-12 cooler has a floating head and removable tube bundle. 1140 square feet of heat transfer surface is contained in a 36" O.D. by 23 ft. long shell.



Used in the production of solid boron fuel, this combination condenser receiver assembly is over 20 ft. high.

23 ft. long lean glycol amine solution cooler.

Vilter has successfully solved many problems of cooling under intense pressures, and has designed and produced hundreds of heat exchangers, pressure vessels, and high pressure synthesis condensers to exacting specifications—explosion proof if necessary—for many types of chemical, petroleum and petrochemical applications.

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Write for helpful bulletins to  
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Milwaukee 7, Wisconsin



## LITERATURE . . .

**Rotary Pumps**.....Rotary screw-type pumps for petroleum and process industries discussed in 42-page bulletin. Includes selection guide and tables of performance data.  
242A DeLaval Steam Turbine Co.

**Turbine Compressor**.....These compressors are made in capacities of 500 cfm to 600,000 cfm. Feature welded closed impellers and rugged casing. Further information.  
22 \*Elliott Company

## Services & Miscellaneous

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215 \*Oakite Products, Inc.

**External Regeneration**.....The practice of externally regenerating ion-exchange units in condensate scavenging systems is subject of 12-page article, Reprint No. T-182.  
242B Graver Water Conditioning Co.

**Package Plants**.....producing oxygen & nitrogen simultaneously plus a new type package Refrigeration Unit. Plants that produce Argon are also available. Information.  
226 \*Independent Engineering Co., Inc.

**Plant Safety System**.....Acting as mainsprings of the system are safety shutoff valves and supervising gas cocks whose controls are in non-hazardous areas.  
242C North American Mfg. Co.

**Plastic Wrapping**.....The versatility and burgeoning use of plastic materials in packaging commercial and industrial products is discussed in 20-page booklet.  
2421 Eastman Chemical Products, Inc.

**Polypropylene Film**.....4-page brochure lists properties of packaging film and includes charts and diagrams to explain specific special characteristics.  
242E AviSun Corp.

**Research Guide**.....Booklet describes 49 outstanding titles and translations of Soviet research in chemistry & metallurgy and also gives prices. Available on request.  
115-116e \*U. S. Industrial Chemicals Co.

**Statistical Technique**.....for investigations involving a large number of variables. It is a non-mathematical method said to give fast & simple answers. No. 1686.  
115-116h \*U. S. Industrial Chemicals Co.

**Tube Cleaner**.....for condenser and heat exchanger tubes. They feature pistol-grip, chrome-moly shafting and flushing action. Bulletin Y-48 is offered.  
216 \*Elliott Company

**Waste Treatment**.....Systems for liquid/solid separation, gravity or pressure separation, by manual, remote or full automatic control or programming are available.  
103 \*Industrial Filter & Pump Mfg.

**Water Service**.....Provides speed, trained technicians and quality parts to remedy your water problem. Complete information on this service is contained in Bul. 100.  
89 \*Layne & Bowler, Inc.

\* From advertisement, this issue



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**McGraw-Hill Publishing Co.**  
**330 West 42nd Street**  
**New York 36, New York**

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**330 West 42nd Street**  
**New York 36, New York**

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Dryer: Porter 2 x 4' vac. drum, st. st.  
Centrifugal: Tolhurst 26" rubber. 2-speed.  
Filter: Sweetland #35 st. st. lined.  
Filter: Elmco, drum 16" x 12".  
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Dryer: Procter & Schwartz 6-tray st. st.  
Mills: Fitz K7 20 hp., D6 7 1/2 hp.  
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2 Oliver Rotary Vac. Filters, 3'x2', 63"x8"  
Day 200 gal. sigma arm Jktd. Mixer, 7 1/2 hp mtr.  
Grundler "BB" Hammormill, whirlbeater, 22"  
Pfaudler 1500 gal. SS Colloid top Tank  
Blaw Knox SS 100 gal. Autoclave, 1000 PSI  
Simpson 18" Lab. Mix Muller, 1/2 HP motor  
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- 1—Charlotte M20ND SS Colloid top Tank.
- 1—Sparkler S.S. Filter 14" & 8".
- 1—Hercules 316SS Filters 16" & 8" sq.
- 1—Day 50 Gal. S.S. Sigma Blade Mixer.
- 1—Wardwhite S.S. Pumps 8" x 6", 3" x 2", 2" x 1 1/2".
- 1—Day 2000 S.S. Spiral Blender.
- 1—Raymond 36" Double Whizzer Separator.
- 1—Rotex Screens 20" x 40" to 60" x 84" S.S.
- 1—Cyclotherm Boiler 20 HP—Oil Fired.
- 1—Mikro 3TH Pulverizer.
- 1—Pfaudler 750 Gal. G.L. Reactor.
- 1—Kent 20 Gal. Super Pony Mixer.

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The Machinery & Equipment Co., Used Div.

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FOR SALE

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- 2—Fletcher 48" Suspended 316 S.S. Perforated Basket.
- 2—Sharples #16, 304 S.S., 3 HP motor.

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- 1—150 gal. 304 S.S. jacketed agitated Reactor.
- 3—Pfaudler 200 gal. glass lined jacketed Kettles.
- 1—300 gal. Hastalloy B jacketed Kettle.
- 1—650 gal. 304 S.S. Reactor with 100 sq. ft. Bayonet Heater.
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- 6—7500, 6000 and 2000 gal. Rubber Lined Tanks.
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- 1—1500 gal. Stainless Pressure Tank, 5' x 10', 90#.
- 1—2,000 gal. horiz. 304 S.S. tank, 5' x 12'.
- 1—2500 gal. vertical 304 S.S. Tank, 8' x 7'.
- 1—12,000 gal. horiz. steel Pressure Tank, 7'6" x 36", 200 psi.
- 6—Stainless Heat Exchangers; 1220, 786, 536, 370, 315, 250 sq. ft.
- 1—24" dia. x 35', 304 S.S. Bubble Cap Column.

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- 1—Oliver 6' dia. Horizontal Filter, 316 S.S.

- 1—Oliver 5' x 6' Steel Rotary Vacuum Precoat Filter.
- 1—U.S. 200 sq. ft. 304 S.S. Auto-Jet Filter.
- 1—Hercules 400 sq. ft. 304 S.S. Pressure Filter.
- 1—Oliver 5'3" x 8' Steel Rotary Vacuum, vaporite housing.
- 1—Feinc 3' x 3' Stainless Steel Rotary Vacuum Filter.
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- 2—#10 Sweetland Filters, 27 leaves, 4" centers, 250 sq. ft.

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- 2—Buflavak 42" x 120", atmospheric double drum Dryers, complete.
- 1—Buflavak 32" x 90" Atmos. Twin Drum Dryer.
- 2—Devine 4' x 9' single drum, atmospheric.
- 1—Buflavak 3' x 10' Rotary Vacuum Dryer.
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- 1—Buflavak 3' x 7'6" x 7'6" Rotary Vacuum Dryers 316 S.S.
- 6—Louisville Rotary Steam Tube 5' x 25', 6' x 30', 6' x 50'.
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- 9—Rotary Dryers 34" x 30', 4' x 40', 6' x 50', 6' x 60', 7' x 80', 8' x 87'.
- 1—Traylor 30" x 18' Stainless Steel Rotary Dryer.
- 2—Link Belt, 7'5" x 25', 6'4" x 24", S.S. Louvre Dryers.
- 2—Atmos. Tray Dryers, 16 shelves, 40" x 24".
- 1—P&S 6' wide Apron Conveyor Dryer 48" long.
- 2—10' and 4' dia. 304 S.S. Spray Dryers.

## MIXERS

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- 2—Day Imperial 150 gal. jkted. double arm.
- 1—Baker Perkins 100 gal. jacketed double, arm, 30 HP.
- 1—Baker Perkins 50 gal. jacketed, double-arm.
- 5—Day 'Cincinnatus' double arm, 250 and 100 gal.
- 2—Steel jacketed Powder Mixers, 225 and 350 cu. ft.
- 1—Patterson 6' dia. Conical Blender 15 HP.
- 1—3' dia. Simpson Intensive Mixer.
- 1—45' dia. Lancaster Mixer 7 1/2 HP motor.
- 1—Patterson Kelly 150 cu. ft. Twin Shell Blender.

## MISCELLANEOUS

- 3—Kinney Vacuum Pumps, 750 cfm, 1 micron, 15 HP.
- 2—Hardinge 5' x 22" steel lined conical Ball Mills.
- 4—Mikro Pulverizers 4TH, 1 SH, 1 SI and Bantam.
- 3—Abbe 2 1/2" x 3' porcelain lined Pebble Mill XP motor.
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- 1—No. 1 Ball & Jewell Rotary Cutter.
- 1—#18 Cumberland Rotary Cutter.
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- 1—#24 Rotex Sifter, 20" x 64", Quad-roped deck.
- 5—Day Roball Sifters, 40" x 120", 40" x 84", Double Deck.
- 3—Nash H6 Vacuum Pumps.
- 4—Stokes Rotary Tablet Machines DD2-DD52-DD53-RB2.

Partial List of Values—Send for Complete Circular

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- 2—Rietz RD-18 Disintegrators heavy duty, w/75 HP 3600 RPM Mtr
- 2—Tolhurst 48" Perf. Bas. SS Centrifuges. 15 HP, w/Plow & Brake
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- 1—Day 40" x 120" Single Deck Screen. 2 HP TEFC Motor
- 2—Sharples H1-5 cont. Nozzle-Jectors SS cont. 7 1/2 HP Mtr



## MACHINERY AND EQUIPMENT COMPANY

123 Townsend St. - San Francisco 7, California

CIRCLE N ON READER SERVICE CARD

**FILTER PRESSES**—6" lead P&F w/pump, 18x18 (26 chamber), 30x30 (11 chamber)

**MILLS**—Hardinge Conical, 3'x8", 3'x24", 5'x22", 8'x36", 8'x48", 6'x12' rod w/200 HP

**VACUUM PUMPS**—115 CFM Beach Russ RP w/5 HP motors, Leiman 105 CFM, Dorr Oliver 200 CFM-piston

**DRYERS—ROTARY**—24"x22", 3'x24", 4'x40' 5'x50', 7'x58", all w/motor drives.

**MIXERS**—New 3 qt. sigma/jacketed, 5 gal. Bramley 5 HP vac./jack., 12 gal. sigma, 22 cu. ft. ribbon blender.

**E. W. LAWLER** has stopped piloting International Jet Liners—Full time super service now for YOU.

**MIKRO BANTAM** w/vari feed drive, 4TH Mikro (unused) w/Mikro collector & 3x5 Tyler screens for closed circuit.

## LAWLER COMPANY

Durham Ave. Liberty 9-0245 Metuchen, N. J.

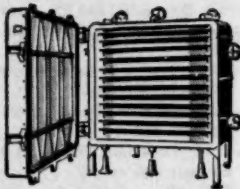
CIRCLE M ON READER SERVICE CARD



## SAVE \$5000. ON THIS DRYER

### SPOTLIGHT SPECIALS

Bufflovak Stainless Sanitary Thermo Compression Evaporator  
 American Jacketed Sterilizer; 2 Door; with Truck; 30" x 48" x 84"  
 Sharples C27 Super-D-Hydrator in Type 316 Stainless; 40 HP  
 Lancaster EAG Muller-Mixer; 5 1/2 Cu. ft.  
 Sturtevant Stainless Micronizers; 30"  
 Acme Stainless Condensers; 1000 sq.ft.



FIRST'S WEEKLY FEATURE  
 FIRST COME—FIRST SERVED  
 Devine Double Door, 20 Shelf Vacuum Chamber Dryer; 86"x78" complete with accessories at a saving of over \$5000.

### DRYERS EVAPORATORS

Louisville MONEL Rotary Steam Tube Dryers; 54" x 35"  
 2 S/S Acme Continuous Rot. Vacuum Dryers or Concentrators  
 Double Drum Dryers of Standard Make; 28" x 60" to 42" x 120"  
 2 F. J. Stokes Vacuum Impregnating Systems; complete  
 Powers Stainless Steel Table Model Spray Dryer; 30" x 32"  
 Bartlett-Snow Jktd. Agtd. Batch Dryer; 6' Dia.; 48 cu. ft.  
 Zaremba Double Effect INCONEL Evaporator with Calandria  
 Link Belt Roto Louvre Dryer; Model No. 502-20

### REACTORS and PRESSURE VESSELS

Struthers Wells 2000 Gal. Stainless Reactors; Jktd. and Agtd.  
 2 Stainless 400 Gal. Reactors Jktd. & Agtd. by Struthers Wells  
 6 Dorr-Oliver 550 Gal. Stainless Thickeners or Reactors  
 2 MONEL Reactors 2800 Gal. 6'8" x 13'; 175# Intern. & Jktd. Coded  
 Pfaudler Glass Lined Reactors, Jacketed, Agitated from 50 Gal. to 1000 Gal.

### MILLS—GRINDERS—PULVERIZERS

Mikro Pulverizers up to No. 4; Mikro S/S Atomers No. 5 and No. 6  
 Fitzpatrick Comminuting Machines, in Stainless; Models C, D and K  
 Abbe Jacketed Steel Ball Mill; 42" x 32"; with charge of balls  
 International Porcelain Lined Pebble Mills; 8'x8'; 50 HP gear motors

### FILTERS and FILTER PRESSES

Oliver Pre-Coat; 3' x 2' Monel; 5'3" x 8' Stainless; 5'3" x 3' Steel  
 Feinc Stainless Steel Rotary Vacuum Filter 3' x 1'  
 4 Pressure Filters in 316 Stainless; 100 sq. ft.; 30" x 56"  
 Sparkler Filters Type 14 S 4 and Type 33 S 17  
 Bowser Filter 200 G.H.P. complete with Pump and Motor  
 Shriver and Sperry Plate & Frame Filter Presses; all sizes

### MIXERS—ALL TYPES

Baker Perkins Double Arm Jacketed Mixers up to 300 Gal.  
 J. H. Day Cincinnati Double Arm Mixer; Stainless 300 Gal. Jktd.  
 Blaw Knox Double Cone Blender 300 cu. ft. 9'6" diameter  
 Brand NEW Falcon Double Ribbon Mixers, Steel or S/S; all sizes

### SPECIAL OFFERING DIRECT FROM LOCATION CONTINUOUS FINE GRINDING EQUIPMENT BEING REMOVED as OPERATIONS TERMINATE

- 2—Allis Chalmers 7' x 22' (2 Compartment) Compab Ball Mills with Meehanite Liners; each with magnetic-coupled 400 HP Motor
  - 1—Allis Chalmers 9 1/2' x 810 Preliminary or Continuous Ball Mill; Meehanite Liners, driven by a magnetic-coupled 400 HP Motor.
  - 3—Allis Chalmers 7' x 22' Continuous Ball Tube Mills with Meehanite Liners, each driven by a magnetic-coupled 400 HP Motor.
- Now Operating in Closed Circuit with
- 3—Raymond 14 ft. Double Whizzer Mechanical Air Separators, New in 1950, each driven by 75 HP Motor. May be purchased separately.

## FIRST MACHINERY CORP.

209-289 TENTH STREET, BROOKLYN 15, N. Y.

FMC Pays MORE  
 For Your Surplus

PARKING ON THE PREMISES  
 Phone: STerling 8-4672  
 Cable Address: "EFFEMCY"



CIRCLE O ON READER SERVICE CARD

## LIQUIDATION OMAHA, NEBRASKA

### MAJOR ITEMS

- 3—1000 KVA transformers, 13800—460 volt.
- 5—Bufflovak 42" x 120" dbl. drum dryers, ASME 160#
- 2—Bonnet 7' x 60' rotary dryers,
- 1—Bonnet 6' x 52' rotary dryer,
- 9—Davenport #1A #2A dewatering presses, vari-drives
- 2—French Oil type 2-S screw-type extraction presses 300 PSI, 60 HP.
- 2—Sweetland #12 pressure filters,
- 6—Shriver 48" Cast Iron P. & F. filter presses, (50) chambers, hydraulic closure, closed deliv.
- 2—19,900 sq. ft. quadruple effect calandria type evaporators, copper tubes, cast iron bodies.
- 5—24" stainless steel screw conveyors, up to 28' long
- 6—Ansonia 691 sq. ft. dbl. pipe coolers, copper tubes
- 3—American 654 sq. ft. spiral steel heat exchangers
- 18—Tubular heat exchangers, copper tubes: 1500, 1350, 1130, 637, 380, 290, 184, 176, 156 sq. ft.
- 1—Leader 96" x 44' high steel beer still, perf. trays
- 4—Leader Iron 96" dia. steel rectifying columns, 44' & 51' high.
- 2—9500 gal. horiz. cookers, 9' dia. x 20' long, 1/2" shell & dished heads, agits.
- 10—Forster hammermills, #8 & #6, 100 & 75 HP.
- 1—Prater "Blue-Streak" pulverizer,
- 1—Fuller 12 x 20 pos. press. blower
- 2—Allis-Chalmers Inter-plane grinders, 100 HP
- 9—Davenport 5' x 25' screens
- 2—Warren 12" x 12" cent. pumps
- 250—Steel centrifugal pumps, 1" to 12", 1 HP to 150 HP
- 2—Aldrich vert. triplex plunger piston-type pumps, steam drive
- 20—Steam turbines, to 150 HP

SEND FOR CIRCULAR #960-A

# PERRY

EQUIPMENT CORP.

1413-21 N. Sixth St.  
 Philadelphia 22, Pa.  
 Phone POplar 3-3505

### CIRCLE P ON READER SERVICE CARD

**BOILERS: HIGH PRESSURE.** We carry a large selection of ASME, National Board high pressure boilers, gas, oil and coal fired, ranging from 10 to 4,000 HP. Each guaranteed in excellent condition. Sale sheet and complete data sent upon request. Write to:

WABASH POWER EQUIPMENT COMPANY  
 3300 W. Peterson Ave., Chicago 45, Ill.  
 Independence 3-0303 and 04.

### CIRCLE Z ON READER SERVICE CARD

### NEW ADVERTISEMENTS

received by February 24th will appear in the March 20th issue subject to limitations of space available.

Classified Advertising Division

CHEMICAL ENGINEERING

P. O. Box 12

New York 36, N. Y.



**JUST PURCHASED**

- 5—F. J. Stokes #138-J6 vacuum shelf dryers, 16 shelves 40" x 44", 195 sq. ft.
- 6—Valley 36" aluminum P. & F. filter presses, 65 chambers, closed delivery, hydraulic closure.
- 1—Vulcan 60" dia. x 35 plate T316SS bubble-cap column, 42' high, Vacuum.
- 1—Hardinge 8' x 48" conical pebble mill, air swept, classifiers.
- 1—Bufflovak 32" x 52" double drum dryer, ASME 100# WP.
- 1—American 42" x 120" double drum dryer, ASME, stainless trim.
- 2—500 gal. T304SS jacketed reactors, ASME, Vacuum, UNUSED.
- 2—8' x 56" rotary kilns, 1/2" welded.
- 4—1350 gal. T347SS jkt. kettles, paddle agit., open top.
- 5—Sweetland #12 pressure filters, 72 stainless leaves.
- 2—Bird 24" x 38" contin. centrifugals, T304SS cylindrical bowl.
- 1—4300 gal. T304SS horiz. tank, 6' dia. x 20' long, ASME 50# WP.

**STAINLESS STEEL TANKS**

- 1—5700 gal., T304SS, horiz., 6'-4" x 24", UNUSED.
- 2—4500 gal., T304SS, 8' x 12', UNUSED.
- 1—4300 gal., T304SS, 6' x 20', ASME 50# WP.
- 1—3700 gal., T304SS, 6' x 17', Coils.
- 1—3400 gal., T304SS, 6' x 16", dishd.
- 1—3300 gal., T304SS, 6' x 14", dishd.
- 1—3200 gal., T304SS, 6'-6" x 12' coils.
- 3—2750 gal., T316SS, 7' x 8', dishd heads, int. coils.
- 1—2500 gal., T316SS, 7' x 7', dishd.
- 2—2300 gal., T316SS, 7' x 8', coils, flat bottom, Agit.
- 3—2250 gal., T316SS, 7' x 6'-3", Agit.
- 1—2100 gal., T316SS, 6' x 9'-10", open top, cone bottom.
- 1—1750 gal., T304SS, 5' x 12', coils.
- 12—1750 gal., T304SS hoppers, 235 cu. ft.
- 1—1600 gal., T304SS, 5' x 11", dishd.
- 1—800 gal., T316SS, 5'-6" x 4'-6".
- 6—685 gal., T316SS, 3' x 10' coils.
- 1—600 gal., T304SS, 5' x 4', dishd.

**AMERICA'S****FIRST CHOICE****FOR DEPENDABLE EQUIPMENT****EVAP. — STILLS****COLUMNS — CONDENSERS**

- 1—Mojonnier 2085 sq. ft. triple-effect Stainless Sanitary evaporator.
- 4—Bufflovak double-effect stainless evap. vert. long-tube type: 1025, 840, 710, 588 sq. ft.
- 1—Stokes 118 sq. ft. T316SS U-tube still.
- 1—Bartlett & Snow 6' dia. Stainless jkt. evap.-crystallizing kettle.
- 1—Vulcan 110" dia. x 16' high T316SS bubble-cap column, 10 trays.
- 1—Vulcan 96" dia. x 37' high, T316SS bubble-cap column, 30 trays.
- 1—96" dia. x 44' high steel beer still.
- 1—Vulcan 60" dia. x 42' high, T316SS bubble-cap column, 35 trays.
- 1—60" dia. x 16' high T316SS bubble-cap column, 10 trays.
- 1—36" dia. x 9'-8" T316SS bubble col.
- 15—Copper bubble-cap columns, 24" to 54" dia., to 51' high.
- 1—1960 sq. ft. T316SS exchanger, remov. bundle, ASME 75# WP.
- 1—1450 sq. ft. T316SS condenser.
- 5—1400 sq. ft. T316SS gas converters.
- 3—800 sq. ft. T316SS condensers.
- 1—730 sq. ft. T316SS exchanger.
- 6—691 sq. ft. copper Dbl. pipe coolers.
- 1—510 sq. ft. T316SS condenser.
- 30—T316SS condensers & exchangers: 427, 425, 410, 400, 290, 277, 264, 250, 200, 185, 165, 150, 145, 105, 83, 73, 54, 52, 50, 47, 30 sq. ft.
- 12—185 sq. ft. T304SS U-tube coolers.

**DRYERS**

- 1—Vulcan 10' x 11' x 175' rotary kiln.
- 2—10 x 78' rot. dryers, 3/4".
- 2—Hardinge 8'-8" x 70" rotary, 3/4".
- 1—Traylor 8' x 80' rotary, 3/4".
- 2—Davenport 8' x 60' rotary, 7/16" welded, burners, fans, etc.
- 1—7'-6" x 62' rotary kiln, 1/2".
- 2—Bonnet 7' x 60' rotary, 3/4".
- 1—Bonnet 6' x 52' rotary, 5/16".
- 1—Louisville 4'-6" x 25' steam-tube.
- 5—Bufflovak 42" x 120" double drum dryers, ASME 160# WP.
- 1—Bufflovak 42" x 90" Dbl. drum.
- 1—American 36" x 84" double drum dryer, ASME, VACUUM.
- 1—Bufflovak 5' x 12', single drum dryer, Vacuum UNUSED.
- 1—Bufflovak 6" x 8" dbl. drum.
- 5—Stokes 195 sq. ft. vac. shelf.
- 2—Bufflovak vac. shelf: 110, 98 sq. ft.
- 1—Bowen Stainless lab. spray dryer.
- 1—Turbulaire Stainless spray dryer.

**MILLS — PULVERIZERS**

- 1—Raymond 66", 6-roll low side.
- 2—Raymond 50", 5-roller hi-side mills, double whizzer.
- 1—B. & W. #E-32, air-swept, 75 HP.
- 1—Mikro #3TH, Stirrup hammers.
- 1—Fitz. #F comminutor, Stainless.
- 2—Hardinge 7' x 36", conical pebble mills.
- 1—Patterson 6' x 10' pebble mill, porcelain lined.
- 12—Abbe Eng. 6' x 8' pebble mills, buhrstone lined, 30 HP.
- 1—Symons 2' Std. cone crusher.
- 1—Farrel 36" x 15" jaw crusher.
- 3—Allis 5' x 22' ball-tube mills.
- 1—Allis 6' x 16', tube mill.
- 1—Allis 5' x 5' ball mill, 75 HP

**SPECIAL LOW PRICE**

- 6—465 gal. T304L Stainless jacketed reactors, 3' dia. x 8'-6" high, 150# WP internal, 165# WP jacket.

**PERRY****EQUIPMENT CORPORATION**

1413-21 N. SIXTH ST.

PHILADELPHIA 22, PA.

**Phone POplar 3-3505**

CIRCLE R ON READER SERVICE CARD





# CHEMICAL EQUIPMENT DIVISION

Proudly Presents

## Another CHEMICAL PLANT LIQUIDATION

at NIAGARA FALLS, N. Y.

Pfaudler 500 Gal. Type ELL Glass Lined, Jktd., Agit. Reactor  
Dopp 1000 & 1700 Gal. Ni-Resist Doppoly, Jktd., Agit. Reactors  
Goslin Birmingham 36"x24" Stainless Rotary Vacuum Filter  
Bufflovak 6"x8" Double Drum Rotary Vacuum Dryer  
A.T.&M. 40" & 30" Stainless Susp. Centrifuges, Perf. & Imperf. Baskets  
Niagara #12 Stainless Steel Jacketed Filter  
Shriver Stainless 18" P&F Closed 4 Eye Washing Filter Press  
Bufflovak 6' Dia. Crystallizers, Atmospheric & Vacuum  
Nash #9, #4, K5 and TS10 Hytor Vacuum Pumps  
Stainless & Copper Stills 3500 to 500 Gal.

### 316 STAINLESS COLUMNS

12"x20" Packed  
36"x21" Packed  
36"x17"—15 Bubble Cap Trays  
48"x40"—40 Bubble Cap Trays  
54"x30"—26 Bubble Cap Trays  
72"x30"—12 Bubble Cap Trays  
78"x18"—21 Bubble Cap Trays

### TANKS

STAINLESS (dished heads)  
11000 gal. horiz. 8'x29'6"  
6000 gal. Vert. 8' x 18'  
5000 gal. Vert. w/coils  
4500 gal. Vert. 8'x12'  
3500 gal. Vert. w/coils  
3500 gal. Horiz. 7'x12'  
3500 gal. Vert. 8'x9'  
1750 gal. Horiz. 6'x8'  
1250 gal. Horiz. 5'x8'  
1200 gal. 5'x8' agit.  
1000 gal. 5'x7' agit.  
950 gal. Vert. 5'x5'  
750 gal. 5'x5' agit.  
500 gal. 3'6"x8' agit.  
500 gal. Vert. w/coils  
400 gal. 4'x4' agit.  
300 gal. 4'x3' cone bot.  
150 gal. 3'x3' agit.  
125 gal. Vert. 2'x5'  
80 gal. Vert. 2'x3'6"

### TANKS

GLASS LINED  
2000 gal. Vert. 6'6"x8'8"  
2000 gal. Horiz. 6'x10'  
750 gal. Horiz. 5'x5'  
400 gal. Vert. 4'x4'

### ALUMINUM

12000 gal. Horiz. 10'x23'  
10000 gal. Horiz. 9'x23'  
7000 gal. Vert. 10'x12'  
6000 gal. Vert. 8'x16'  
1500 gal. Vert. 5'x10'  
750 gal. Vert. 4'6"x6'

### COPPER

3500 gal. 8'x9' w/coils  
3000 gal. 8'x8' w/coils  
2000 gal. 7'x7' w/coils  
500 gal. 4'x5' w/coils

### STEEL

22000 gal. Vert. 12'x25'  
11000 gal. Horiz. 8'x30'  
8500 gal. Vert. 8'x22'  
5000 gal. Horiz. 8'x12'  
5000 to 250 gal. (50)

### COPPER COLUMNS

24"x 8"—15 Bubble Cap Trays  
24"x17"—24 Bubble Cap Trays  
30"x11"—12 Bubble Cap Trays  
36"x12"—15 Bubble Cap Trays  
48"x15"—26 Bubble Cap Trays  
48"x31"—50 Bubble Cap Trays  
72"x16"—16 Bubble Cap Trays

### HEAT EXCHANGERS

2300 sq. ft. Stainless tubes  
1000 sq. ft. All Stainless  
600 sq. ft. Stainless tubes  
600 sq. ft. Copper tubes  
420 sq. ft. All Stainless  
300 sq. ft. Stainless tubes  
235 sq. ft. Stainless tubes  
150 sq. ft. All Stainless  
100 sq. ft. Stainless tubes  
80 sq. ft. Stainless tubes  
68 sq. ft. Stainless tubes  
30 sq. ft. Stainless tubes  
Glass Lined, jktd 30"x6'

### S.S. CENTRIF. PUMPS

2x2" Model 15 DLP LaBour  
2x2" Model H15-17 Durco  
2x1 1/2" 40-24MD Durco  
1 1/2x1" Model DHL LaBour

STAINLESS  
COPPER, STEEL, ALUM.  
VALVES, PIPE & TUBING

### MISCELLANEOUS

Model "D" Fitzpatrick Comminuter  
Squire 500 sq. ft. tray truck drier  
Str. Wells Electric EH3 Dowtherm Heater  
Anders Automatic Air Dehydrator  
Dorr Thickeners 20'x4'  
Duriron Vessels 1000 to 100 gallon  
Foots Bros. gear reducers Type 25W

Swenson 24"x20' Stainless 316  
Crystallizer, Jktd.  
Roots Connorsville 8"x24" Displacement  
Meter Blower 60000 CFH  
Norwalk Compressor Type SRSSR,  
15000 PSI  
Cleveland Size 400—VD gear reducers

Your Inspection Invited—Representatives on Premises  
Write—Wire—Phone for Complete Information

# HEAT & POWER CO., Inc.

60 East 42 Street, New York 17, N. Y. Murray Hill 7-5280  
Site Office—Pine Ave. & 47th St., Niagara Falls, N. Y. Butler 5-3644

CIRCLE 5 ON READER SERVICE CARD

LOCOMOTIVES—RR CARS & CRANES  
9 Gen. Elec. 20, 25, 45, 65, 80, 100 & 125 Ton  
25-Ton Industrial Brownhoist, 60' Boom Crane  
200—50 Ton Box, 300—70 Ton Gondola Cars

### PLANT EQUIPMENT

4' Traylor TV Gyratory Crusher  
2—Wemco 2M-HMS Plants  
No. 5060 Dixie Mogul Hammermill 500 HP  
No. 1 Sturtevant Rotary Fine Reduction Crusher  
FSS Syntrol Grizzly Feeder  
10—1 1/2 & 2 Yd. V-Shape Dump Cars  
2—5' x 3' KVS Air Sweet Ball Tube Mills  
Ball Mills: No. 56, 5' x 5', 6' x 4' x 9' & 7' x 22'  
Hardinge Mills: 3' x 8', 3' x 24' & 10' x 48',  
6' x 22'  
Rod Mills: 4' x 11', 6' x 12' & 7' x 15'  
Jaw Crushers: 8' x 10', 10' x 20', 14' x 28', 18' x  
36', 30' x 30', 48' x 60', 60' x 72', 60' x 84'  
Crushers, Fine Reduction: 22', 2', 3', 4', 5 1/2', &  
7' 8/8 Cone  
Crushers, Roll: 24' x 14', 30' x 14', 40' x 16'  
Rotary Dryers: 3' x 30', 5' x 30', 6' x 50', 6' x 70'  
& 8' x 80'  
Rotary Kilns: 36"x30', 6'x70', 7'x120' & 9'x160'  
2—42" x 120" Builovak Atmos. Double Drum Dryer  
Roto Louvre #207-10 Type 316 SS, Link Belt  
60—1 1/2, 2 & 4 yd Dump Cars  
Laboratory Rotary Kiln, 36" x 30', Complete  
4' x 10' Tyler-Hummer Electric Vibrating Screen  
2' x 6' & 3' x 12' Seep Single Deck Vibrating Screen  
2—6' x 12' Allis Chalmers 2 Deck Vibrating Screens  
16' Gayco Centrifugal Air Separator  
BX-100 Sutton Steele & Steele Air Table NEW  
6—30" x 32" Dings Magneto Head Pulleys  
600', 2200', 3066' & 3600'-I.R. Compressors  
4100 CFM S.V. Dust Collector  
WANT BUY DRYERS—KILNS—CRUSHERS  
R. C. Stanhope, Inc., 60 E. 42 St., N.Y. 17, N.Y.  
Tel. MU 2-3075

CIRCLE T ON READER SERVICE CARD

### COMPRESSORS

No better values at any price

85 CFM (Actual) 3500 PSI Clark HO-6-4C  
110 CFM 3000 PSI Ing. GC 50BW  
138 CFM 100 PSI 7-7, Ing. ES, CP & Joy  
288 CFM 100 PSI 9x9 Ing. Worth, CP  
311 CFM 1500 PSI 10 1/2-7 1/2-3 1/2-13 IR-E53  
351 CFM 350 PSI 11-5x11 CP TCB-2  
384 CFM 100 PSI 10x9 Joy W-9  
465 CFM 100 PSI 12x11-IR-ES CP.T, Worth HB  
502 CFM 125 PSI 12x13 Worth HB  
553 CFM 110 PSI 13 1/2-8 1/2-5x8 Worth, DC 2  
586 CFM 100 PSI 14x13 Ing. ES  
800 CFM 100 PSI 14 1/2-9x7 Ing. XLE  
1050 CFM 60 PSI 13-13x12 IR-XRE  
1290 CFM 125 PSI 13/8x7 Joy W-114-E  
2200 CFM 100 PSI 26-15x18 Ch. Pn. oec 350 HP  
3-6-4600 .8 PF  
2820 CFM 125 PSI 17-10 1/2x8 Clark CMA-4L

AMERICAN AIR COMPRESSOR CORP.  
Chem. Road, North Bergen, N.J. Union 5-1397

CIRCLE U ON READER SERVICE CARD

Screener 2 Deck S.S., also steel

Micro Atomizer S.S.

Reactors 500 gal.—750 gal steel

Baker Perkins—100 gal—50 HP, S.S.  
2 arm jacketed-vacuum hdr. tilt

Aluminum Evaporator Calandria type—  
never used—1300 sq. ft. tube area

Hydraulic Pumps & motors.

MACHINECRAFT CORPORATION

800 Wilson Ave. (East of Doremus)  
Newark 5, N. J. MI 2-7634

CIRCLE V ON READER SERVICE CARD

## OUTSTANDING VALUES!

SS jktd. & agit. Reactors 400, 125,  
50 gal.  
Hershey steel hot air rot. Dryer  
1 1/2'x16'  
Stokes rot. vac. Dryers 18"x42",  
2 1/2'x8'  
Porter 28 cu. ft. double cone Blender  
CHEMICAL & PROCESS MACHINERY CORP.  
50-52 9th St., Brooklyn 15, N. Y. NY-9-7200

CIRCLE W ON READER SERVICE CARD

Buying

Good USED Equipment

is frequently the difference be-  
tween having needed equipment  
or doing without it.

# Get in the swim-Now!

## Buy

# GELB

## CHEMICAL PROCESS EQUIPMENT

- 1-Baker Perkins 55 double arm sigma blade mixer, 9 gal.
- 1-Robinson stainless steel 125 cu. ft. horizontal double ribbon blender
- 1-Raymond 2 roll high side roller mill
- 1-Oliver 55 rotary vacuum pressure precoat filter, 5'3" x 8'

### AUTOClaves, KETTLES & REACTORS

- 2-Blaw Knox 600 gal. steel reactors, complete with double motion agitators and drives, 50# jacket, 50# internal
- 1-Steel 1200 gal. vertical pressure tank, 150 psi
- 3-Theo. Walters 300 gal. Hastelloy B jacketed reactors
- 1-Van Alst 300 gal. stainless steel jacketed kettle
- 1-Blaw Knox 300 gal. stainless steel vacuum reactor
- 1-Pfaudler Series EL 750 gal. glass lined jacketed reactor, 90# working pressure jacket, complete with impeller type agitator, baffle and drive
- 1-Pfaudler 30 gal. Series P, jacketed reactor, complete with impeller type agitator, baffle and drive
- 1-Struthers Wells type 316 SS jacketed reactor 2000 gal. complete with agitator and drive

### DRYERS

- 2-Bonnet rotary kilns, 8' x 115', complete
- 1-Bonnet rotary cooler, 8' x 50', complete
- 1-Allis Chalmers stainless steel rotary dryer, 6' x 50', complete
- 1-Allis Chalmers rotary dryers, 6' x 50' and 7' x 60'
- 3-Link Belt steel roto louver dryers, Model 207-10, 310-16, 604-20
- 2-Buflavak stainless steel rotary vacuum dryers, 5' x 30'
- 1-Buflavak SS jacketed rotary vacuum dryer, 3' x 15'
- 2-Stokes SS jacketed rotary vacuum dryers, 3' x 15' and 2' x 6'
- 1-American 42" x 120" double drum dryer, ASME, N. B. constructed, complete with drives and motors
- 3-Buflavak steel jacketed rotary dryers, 3' x 15', 5' x 20', 5' x 35'
- 1-Western Precipitation Corp. SS pilot plant spray dryer, Type N-2
- 1-Bowen Stainless Steel pilot plant spray dryer
- 1-Stokes single door vacuum shelf dryer with 6 shelves, 24" x 36"

### FILTERS

- 12-Sweetland #12 filters with 72 stainless steel leaves
- 1-Niagara stainless steel filter, Model 510-28
- 1-Oliver horizontal filter, 3'
- 1-Oliver stainless steel rotary vacuum filter, 3' x 4'
- 1-Shriver aluminum 30" x 30" P&F filter press, 30 chambers
- 10-Shriver plate and frame filter presses 12" to 42"

### CENTRIFUGES

- 1-AT&M 48" stainless steel, suspended type centrifuge, complete with plow, motor and imperforate basket
- 1-Fletcher 48" stainless steel, underdriven centrifuge, complete with perforate basket and motor
- 7-Western States 40" type 316 SS, suspended type centrifuges, complete with perforate baskets, plows and 40 HP motors
- 1AT&M 26 type 316 SS, suspended type centrifuge, complete with perforate basket, plow and motor
- 4-Tolhurst 40" center slung rubber covered centrifuges, complete with perforate baskets and motors



THE GELB GIRL—FEBRUARY 1961

- 1-Tolhurst 30" center slung rubber covered centrifuge, with perforate basket and motor

### MIXERS

- 2-Sturtevant #7 dustite rotary batch blenders, NEW
- 15-Robinson type 304 SS horizontal blenders, 255 cu. ft.
- 1-Baker Perkins, Size 16, Type UUEM, 150 gal. jacketed double arm dispersion type mixer, complete with compression cover and 100 HP motor
- 1-Stokes stainless steel granulating mixer, Model 21-J
- 1-Colton stainless steel granulator, Model 561-S

### MISCELLANEOUS

- 1-Stewart Bolling 2 roll chrome plated, plastic mill, 8" x 16"
- 1-Ross 6" x 14", 3 roll paint mill, high speed, complete
- 1-Vulcan stainless steel bubble cap column, 4' x 25 plates
- 1-Badger type 316 SS bubble cap column, 42" diam. with 11 trays
- 1-Badger type 316 SS bubble cap column, 36" dia. with 8 trays
- 1-Struthers Wells type 316 SS heat exchanger, 330 sq. ft.
- 1-Condenser Service type 316 SS heat exchanger, 350 sq. ft.
- 3-Badger type 316 SS heat exchangers, 500 and 600 sq. ft.
- 1-Downington type 316 SS heat exchanger, 750 sq. ft.
- 1-Griscom Russell stainless steel heat exchanger, 900 sq. ft.
- 4-Patterson type 316 SS condensers, 200 and 300 sq. ft.
- 20-Davis Engineering stainless steel heat exchangers, 102, 119, 136, 166 sq. ft. NEW
- 4-Davis Engineering Carpenter 20 heat exchangers, 125 sq. ft. NEW
- 2-Swenson type 316 SS vacuum crystallizers, 3'6" x 12' and 2' x 12'
- 3-Mikro #1SH pulverizers, complete
- 1-Mikro #2TH pulverizers, complete
- 2-Mikro #3TH stainless steel pulverizers, complete with 40 HP motors

- 1-J. H. Day SS double arm sigma blade, vacuum jacketed mixer, 5 gal.
- 1-Hersey stainless steel rotary dryer, 3' x 20'
- 1-Alloy Fabricators SS jacketed reactor, 400 gal., complete with turbine agitator and Mixco drive
- 1-Pfaudler Series EM 300 gal. glass lined jacketed reactor, complete with anchor type agitator and drive

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# 75

ANNIVERSARY

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**Index of Advertisers**

ACF Industries, Inc.	65
WKM Division	236
Adams Co., R. P.	190
Aldrich Pump Co.	59
Allen Bradley Co.	79
Allied Chemical Corp.	30
General Chemical Div.	161
(Baker & Adamson)	20-21
Alloy Steel Products Co.	183
Aluminum Co. of America	8-9
Chemicals Div.	18-19, 198
Rome Cable Div.	167
Amercoat Corp.	125
American Cyanamid Co.	232
American Machine and Metals, Inc.	1
American Smelting & Refining Co.	62
Federated Metals Div.	251
Anaconda American Brass Co.	239
Anderson Co., V. D.	250
Appleton Electric Co.	67
Armco Steel Co.	196
Atlas Mineral Products Co.	2
Barneby-Cheney Co.	56
Beckman Instrument Co.	68
Bell & Gossett Co.	25
Belmont Packing & Rubber Co.	237
Bird Machine Co.	33
Bristol Co.	211
Buell Engineering Co.	80-B
Buffalo Forge Co.	124
Burgess-Manning Co.	155
Cambridge Wire Cloth Co.	16-17
Celanese Corp. of America	173
Chemical Engineering	233
Chempump Division	64
Fostoria Corporation	201
Chiksan Co.	200
Clayton Mark & Co.	74
Cleveland Worm & Gear, Div. of	222
Eaton Mfg. Co.	212
Consolidated Vacuum Corp.	212
Cook Co., C. Lee	195
Corning Glass Works	159
Croll-Reynolds, Inc.	238
Crouse-Hinds Co.	198
Dahl Co., G. W.	107
Darling Valve & Mfg. Co.	50
Day Co., J. H.	241
Day Co., The	194
Dean Products, Inc.	69
DeBothezat Division	239
Deming Company	181
Dow Chemical Co.	220
Saran Lined Pipe Co.	188
Dow Corning Corp.	39
Ducon Company	179
du Pont de Nemours & Co. (Inc.), E. I.	22, 216
Fabrics	235
Durametallic Corp.	203
Duriron Company, Inc., The	240
duVerre, Inc.	43
Dynametrics Corp.	238
Eco Engineering Co.	236
Electric Controller & Mfg. Div. of	95
Square D Company	26
Elliott Co.	230
Eriez Mfg. Co.	191
Esso Standard, Div. of	251
Humble Oil & Refining Co.	117
Falcon Manufacturing Div.	109
First Machinery Corp.	209
Fibercast Company, a Division of	23
Youngstown Sheet and Tube Co.	70
Fike Metal Products Corp.	187
Fisher Governor Co.	101
Flexitallic Gasket Co.	36
Foxboro Co.	51
Gast Mfg. Co.	99
General American Transportation Corp.	6-7
Turbo Mixers	
General Electric Co. (Silicones)	
Georgia Dept. of Commerce	
Girdler Process Equipment Div. of	
Chemetron Corp.	
Gould Pumps, Inc.	
Great Lakes Carbon Co.	
Dicalite Division	
Grinnell Co.	
Griscom-Russell Co.	
Hagan Chemicals & Controls, Inc.	
Hercules Powder Co.	
Hoke, Inc.	
Hooker Chemical Corp.	
Hydromatics, Inc.	

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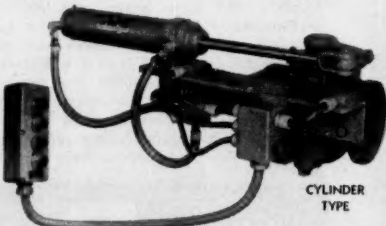
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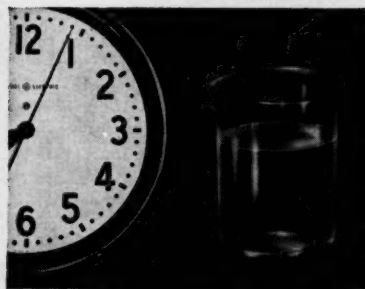
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**GENERAL ELECTRIC**

Independent Engineering Co.	226
Industrial Filter & Pump Co.	103
Ingersoll-Rand	87
International Business Machines	157
Jenkins Bros.	45
Johns-Manville Corp. (Cellite)	44
Joy Manufacturing Co.	31
Kemp Mfg. Co., C. M.	177
Kendall Co. (Polyken Products)	217
Kennametal, Inc.	214
Lapp Insulator Co. (Pulsafeeder)	49
Lawrence Pumps, Inc.	202
Layne & Bowler, Inc.	89
Lummus Co.	197
Marathon, Div. of American Can Co.	208
Marley Co.	29
Marlo Coil Co.	54
Metal Hydrides, Inc.	175
Mine Safety Appliances Co.	192-193
Minneapolis-Honeywell	91
Mixing Equipment Co.	Fourth Cover
Monsanto Chemical Co.	199
Morehouse-Cowles, Inc.	24
National Airoil Burner Co.	185
National Engineering Co.	123
Neptune Meter Co.	46
NETCO Corporation	163
Newport News Shipbuilding & Dry Dock	48
Oakite Products, Inc.	215
Olin-Mathieson Chemical Corp.	224
Owens-Illinois	
Subsidiary—Kimble Glass Co.	113
Parks-Cramer Co.	250
Partlow Corp.	34-35
Patterson-Kelley Co.	76-77
Peerless Pump, Hydrodynamic Div.	
Food Machinery & Chem. Corp.	10-11
Penfield Manufacturing Co.	240
Pfautler Co., Div. of Pfautler	
Permutit, Inc.	12-13
Phelps Dodge Copper Products Co.	27
Philadelphia Gear Corp.	58
Platecoil Division of Tranter Manufacturing, Inc.	66
Posey Iron Works, Inc.	238
Prater Pulverizer Co.	222
Premier Mill Corp.	252
Pressed Steel Tank Co.	4
Purolator Products Co.	221
Quaker Oats Co., Chemical Div.	85
Raybestos-Manhattan, Inc.	
Manhattan Rubber Div.	40
Republic Flow Meters Co.	218
Richardson Scale Co.	210
Robertshaw Fulton Controls Co.	
Aeronautical & Instrument Div.	41

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## ADVERTISERS . . .

Rockwell Mfg. Co. (Ind. Meters) . . .	111
Rockwood Sprinkler (Ball Valves) . . .	
Div. of Gamewell Corp. . . . .	57
Ronningen-Petter Co. . . . .	225
Sarco Company . . . . .	60
Schutte & Koerting Co. . . . .	63
Scovill Mfg. Co. . . . .	189
Selas Flotronics, Div. of Selas Corp. of America . . . . .	252
Sharples Corp. . . . .	97
Shriver & Co., T. . . . .	52
Sly Mfg. Co., W. W. . . . .	223
Smith Corp., A. O. . . . .	81
Snam . . . . .	156-A
Solema . . . . .	80-A
Southwestern Engineering Co. . . . .	93
Sperry & Co., D. R. . . . .	61
Spraying Systems Co. . . . .	232
Sproul, Waldron & Co. . . . .	231
Square D Company . . . . .	
EC & M Division . . . . .	179
Stokes Corp., F. J. . . . .	14-15
Sturtevant Mill Co. . . . .	241
Sulzer Bros., Inc. . . . .	225
Surface Combustion, Div. of Midland-Ross Corp. . . . .	204
Swenson Evaporator Co., Div. of Whiting Corp. . . . .	206, 207
Systems Engrg. & Mfg. Co., Inc. . . . .	234
Taber Pump Co. . . . .	234
Taylor Instrument Companies . . . . .	114
Titanium Metals Corp. of America . . . . .	171
Traylor Engineering & Mfg. Div. of Fuller Co. . . . .	28
United Engineers & Constructors, Inc. . . . .	32
U. S. Industrial Chemicals Co. Div. of National Distillers & Chemicals Corp. . . . .	115-116
Vickers, Inc. . . . .	
Subsidiary of Sperry Rand Corp. . . . .	169
Vilfr Manufacturing Co. . . . .	242
Vogt Machine Co., Henry . . . . .	126
Voss Co., Inc., J. H. H. . . . .	230
Wagner Electric Corp. . . . .	42
Waukesha Foundry Co. . . . .	205
Weighing & Controls Corp. . . . .	213
Wellington Sears Co. . . . .	219
Western Supply Co. . . . .	165
Westinghouse Electric Corp. . . . .	53
Wilfley & Sons, A. R. . . . .	Third Cover
WKM Division of . . . . .	
ACF Industries, Inc. . . . .	65
Wolverine Tube, Division of Calumet & Hecla . . . . .	37-38
Worthington Corp. . . . .	Second Cover
Wyandotte Chemicals Corp. Michigan Alkali Div. . . . .	71-72
Yarnall-Waring Co. . . . .	55
Yuba Consolidated Industries . . . . .	47

Professional Services . . . . . 243

### CLASSIFIED ADVERTISING

F. J. Eberle, Business Mgr.

EMPLOYMENT OPPORTUNITIES . . . 243

SPECIAL SERVICES . . . . . 244

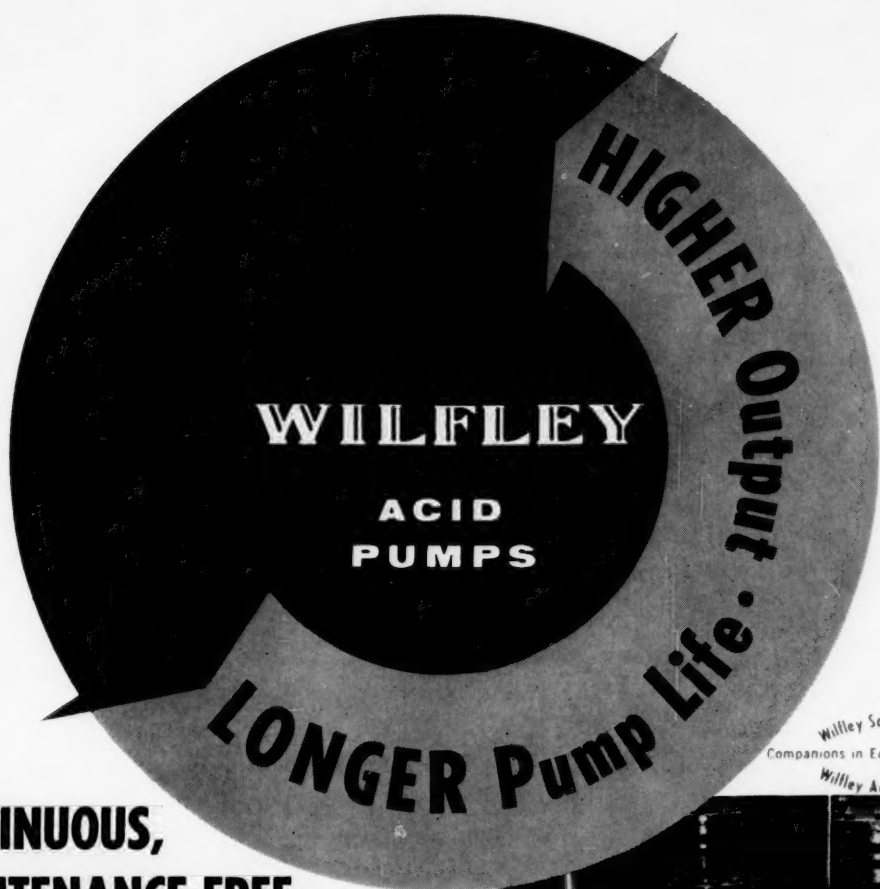
### EQUIPMENT

(Used or Surplus New)

For Sale . . . . . 244-249

### ADVERTISERS INDEX

American Air Compressor Corp. . . . .	248
Brill Equipment Co. . . . .	245
Chemical & Process Machinery Co. . . . .	248
Equipment Clearing House Inc. . . . .	244
Esquire Personnel . . . . .	243
First Machinery Corp. . . . .	246
Gelb & Sons, Inc., R. . . . .	249
Harvey Aluminum (Inc.) . . . . .	243
Heat & Power Co., Inc. . . . .	248
Joyce Equipment Co. . . . .	244
Lawler Co. . . . .	245
Loeb Equipment Supply Co. . . . .	244
Machinecraft Corp. . . . .	248
Machinery & Equipment Co. . . . .	245
Machinery & Equipment Co., Used Div. of Haring Equipment Corp. . . . .	244
McGraw-Hill Publishing Co. . . . .	243
McKee & Co., Arthur G. . . . .	243
Micro Metals Corp. . . . .	244
Perry Equipment Corp. . . . .	246, 247
Secheurs Atomiseurs Co. . . . .	244
Stanhope Inc., R. C. . . . .	248
Stein Equipment Co. . . . .	244
Union Standard Equipment Co. . . . .	244
Wabash Power Equipment Co. . . . .	246
Wabash Inc., Charles . . . . .	244
Wilmont & Cassidy Inc. . . . .	244



Wilfley Sand Pumps  
Companions in Economical Operation  
Wilfley Acid Pumps

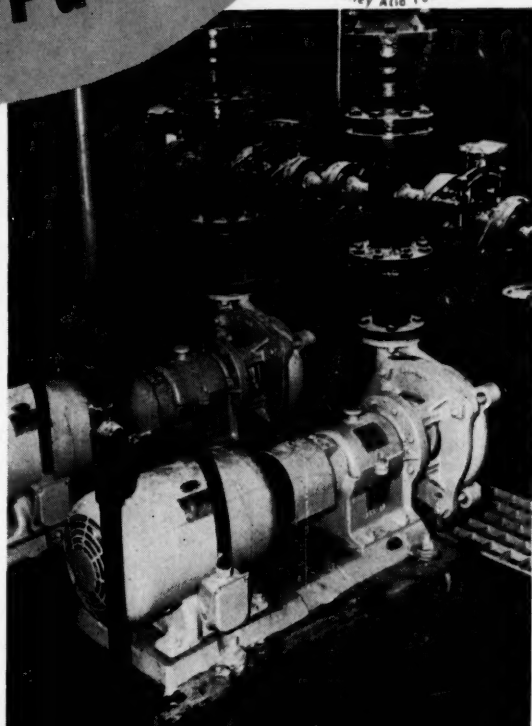
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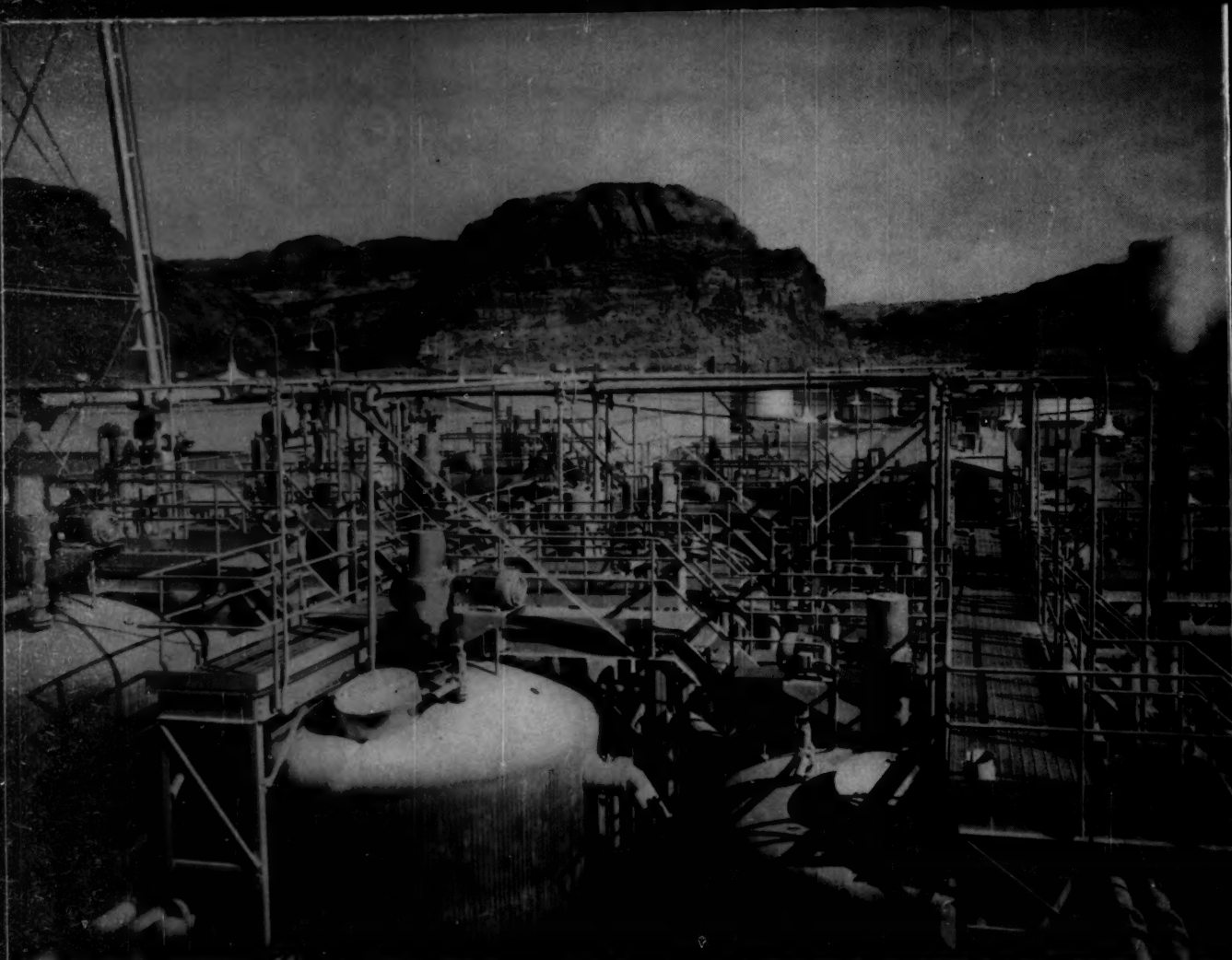
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